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CANADIAN BARK-BEETLES

PART II

A PRELIMINARY CLASSIFICATION, WITH AN ACCOUNT OF THE HABITS AND MEANS OF CONTROL

BY
J. M. SWAINE,
Assistant Entomologist in Charge of Forest Insect Investigations

BULLETIN No. 14
(*Technical Bulletin*)

Published by direction of the Hon. T. A. Crerar, Minister of Agriculture, Ottawa

OTTAWA
J. DE LABROQUERIE TACHÉ
PRINTER TO THE KING'S MOST EXCELLENT MAJESTY
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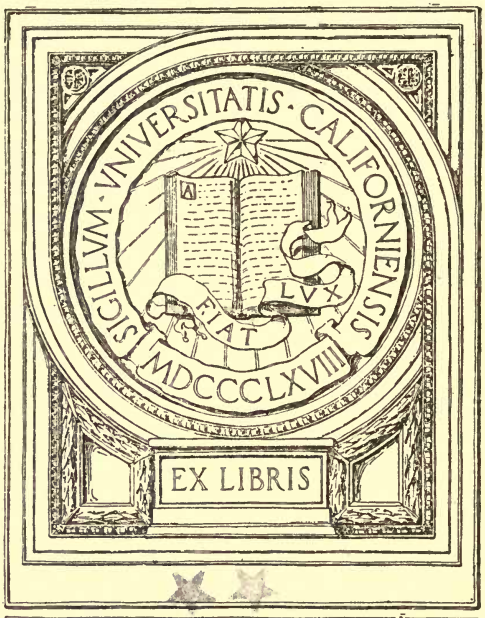

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DEPARTMENT OF AGRICULTURE,
OTTAWA, September 14, 1917.

To the Honourable
The Minister of Agriculture,
Ottawa, Ont.

SIR,—I have the honour to submit, for your approval, Entomological Bulletin No. 14, Part II, entitled "Canadian Bark-Beetles; Part II: A Preliminary Classification, with an Account of the Habits and Means of Control," which has been written by Mr. J. M. Swaine, Assistant Entomologist in charge of Forest Insect Investigations.

As I pointed out in Part I of this series, the bark-beetles constitute the chief insect enemies of our coniferous forests. Forest fires are spectacular, and the results are immediately and strikingly noticeable, but competent authorities are of the opinion that the annual loss caused by the depredations of these and other forest insects which are widely distributed throughout the country is greater in the aggregate than the loss due to forest fires.

The methods to be adopted to control the outbreaks of these serious enemies of our forests depend upon a knowledge of the species of bark-beetles concerned. Different species have different habits, and as control measures are based upon their habits it is necessary for the forester to be able to recognize the various species that are to be found affecting our timber and shade trees. The object of this bulletin, which brings together the results of the work of many years, is to place in the hands of foresters, students, and other workers requiring such information, a means whereby they will be able to identify readily the species of bark-beetles causing any injuries that may be found in our Canadian forests. An account of the general habits and of the methods of controlling bark-beetle outbreaks is included, and descriptions are given of a number of new species.

At the present time the protection and correct utilization of our timber resources is of greater importance than ever from a national and imperial standpoint. When the information contained in this bulletin is available to practical foresters it will be of inestimable practical value, as it will assist them in taking the necessary steps to prevent the continued loss of timber now being destroyed and to protect extensive areas that are threatened by the attacks of bark-beetles, most insidious enemies of the forest.

I have the honour to be, sir,

Your obedient servant,

C. GORDON HEWITT,
Dominion Entomologist and Consulting Zoologist.

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Canadian Bark-beetles.

PART II. A PRELIMINARY CLASSIFICATION, WITH AN ACCOUNT OF THE HABITS, INJURIES AND MEANS OF CONTROL.

By J. M. Swaine

INTRODUCTION.

This bulletin has been written with the object of assisting students and practical foresters in determining the bark-beetles of Canadian forests. The majority of the species occurring in the northern regions of the United States have also been included, since nearly all may eventually be found in Canada.

The bark-beetles of this country have thus far received but little attention from most collectors and students of the Coleoptera. There were until recently so many common species undescribed, and the older descriptions were so incomplete, that their determination was frequently given up as a hopeless task. Furthermore, while many of the species may be obtained in quantity, when the collector knows their habits, most of the bark-beetles are taken only in the bark or wood of their host trees, and then only by those who seek them. Owing probably to these two causes our literature shows a lamentable dearth of biological papers on North American bark-beetles. While the life-histories and habits of the European species have been discussed in scores of papers, the habits of very few of ours have been published, excepting the species of the genus *Dendroctonus*.

There are still numbers of our species undescribed. Some have been received or collected since these keys were finally revised. Others are represented in our collection by one or two specimens, and may prove to be only marked variations, and there are many other species, undoubtedly, that have not yet been collected.

The study of a group of beetles containing so many destructive enemies of forests and shade trees is of particular importance. Careful and detailed studies of the structural characters and habits must be made so that the injurious species may be readily determined and practical remedies perfected. A single dying pine or spruce may contain many species of bark-beetles working in the bark and wood. The entomologist must be able to determine all the different species he meets and must have a working knowledge of the habits of all of them so that, with the assistance of the evidence before him in the trees themselves, he may be able to select the species responsible for the primary injury to the timber. It is evident, therefore, that intensive laboratory studies upon the morphology and classification of the beetles are absolutely necessary, and that time spent upon even the species of apparently minor economic importance may give decidedly practical results.

Mr. A. E. Kellett, Artist Assistant in the Entomological Branch, has drawn the illustrations which bear his signature, under the supervision of the writer, and has prepared many of the photographs. The writer is indebted to many students of the Coleoptera and to several institutions for the privilege of studying their collections. This assistance will be acknowledged more fully in later publications dealing with the biology of the species.

I.

THE BEETLES AND THEIR HABITS.

The Life Stages.

The Bark-beetles are small, usually cylindric beetles, from one to nine millimetres in length, and brownish or black in colour when mature. They are found in company with their small, whitish, legless grubs, cutting tunnels in the bark or wood of trees. Figures on plates 4 and 5 illustrate types of the tunnels cut by them.

In common with other beetles there are four life stages: the egg, the larva or grub, the pupa or resting stage, and the adult beetle.

The *eggs* are usually oval, elongate-oval, subglobular, or rarely somewhat elongate; pearly white or translucent and watery; with a very delicate covering when deposited in niches and packed with boring dust, but with a thicker skin when left loose in the galleries (Pl. 3, figs. 1, 3). The surf ce modifications appear to be of minor importance. They are, of course, very small, but sometimes of an astonishing size in relation to the size of the mother beetle. The eggs of *Cryphalus* are almost as large as the beetle's abdomen.

The *larvæ* are always legless, whitish in colour, with darker, strongly chitinized head and mandibles, and with the thoracic segments distinctly larger than the others, in the true bark beetles (Pl. 1, fig. 2). In ambrosia-beetles of the genera *Anisandrus* and *Xyleborus*, the larvæ move about freely in the tunnels, and they are more elongate and distinctly more mobile than the others.

The characters of the larvæ will prove of considerable assistance in the classification of the family; and in addition, they are of decided practical value, since not infrequently the larvæ alone are obtainable in material sent in for determination. A discussion of the larval characters, however, must be left for a later publication.

A distinct prepupal, quiescent stage, lasting a few days, is common in the family.

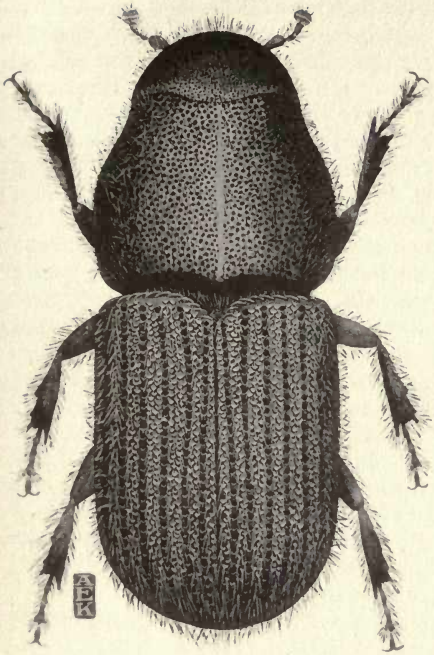
The *pupæ* are formed in the ends of the larval mines, sometimes in pupal cells. They are white at first, becoming yellowish before transformation. They are variably armed with spines and stiff setæ, and present characters of decided importance (Pl. 1, fig. 3). The adults are yellowish when they emerge from the pupal skin, but rapidly become darker in colour, passing through yellow to reddish and dark brown or nearly black.

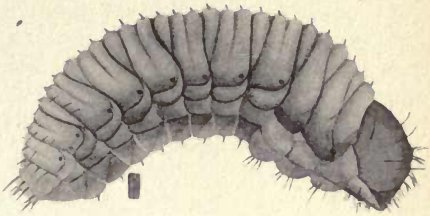
PLATE 1.

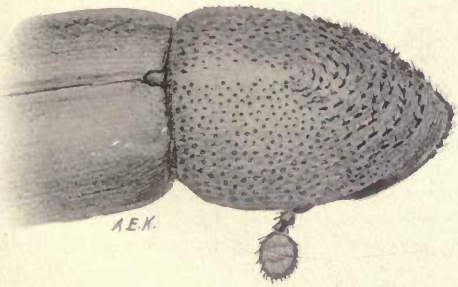
IPID BEETLES, All Greatly Enlarged. (Original.)

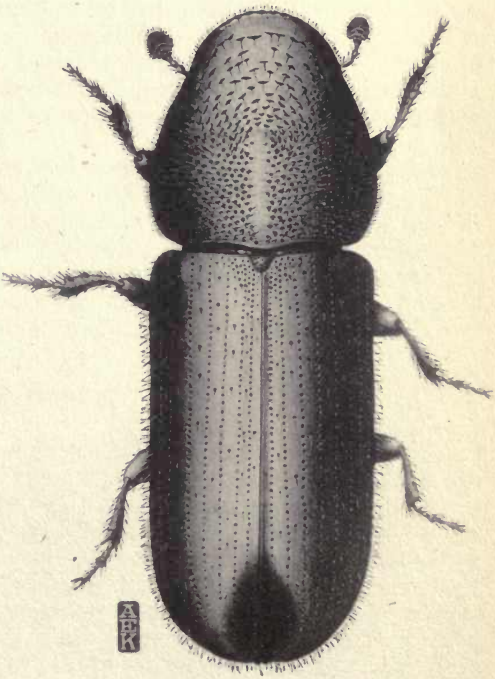
Fig. 1, *Dendroctonus monticolae* Hopk., upper left.
Fig. 2, *Dendroctonus monticolae* Hopk., larva, upper right.
Fig. 3, *Dendroctonus borealis* Hopk., pupa, right centre.
Fig. 4, *Pityophthorus nitidus* Sw., lower right,
Fig. 5, *Pityophthorus nitidus* Sw., details of the pronotum, left centre, autenna incorrect.
Fig. 6, *Pityophthorus nitidus* Sw., caudal view of the declivity, lower left.

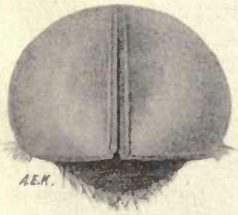
PLATE No. 1.











General Habits.

In habits the *Ipidæ* of our fauna form a sharply isolated group. Their tunnels, cut usually in the bark or wood of trees, are characteristic of the family. Our species present two quite distinctive habits, corresponding to which they have been termed True Bark-beetles and Ambrosia-beetles, respectively. The former, with very few exceptions, cut their tunnels entirely or almost entirely in the bark or between the bark and the wood; the latter, on the other hand, penetrate the wood and the young develop in the tunnels well below the wood surface, nourished entirely by a peculiar fungus called Ambrosia, which grows invariably upon the tunnel walls and stains them dark brown or black.

With True Bark-beetles the typical habit is as follows: An entrance tunnel is cut obliquely upward through the bark to the wood surface. From the base or inner end of the entrance tunnel one or two or more egg-tunnels are cut, vertically, transversely, or in a radiate fashion, between the bark and the wood along the wood surface. With many species a small, flat cavity, the nuptial chamber, is excavated at the base of the entrance hole, and from it the egg-tunnels originate. The eggs are laid along the sides of the egg-tunnels, singly in cup-shaped egg-niches, a few together in larger egg-pockets, or many in layers and egg-grooves. The egg-tunnels and entrance hole are uniform in size, slightly larger than the diameter of the beetle, and perfectly cylindric. The larvæ excavate slender mines through the inner bark or between the bark and sapwood, away from the egg-tunnels. The larval mines are filled with excrement and increase gradually in diameter as the larvæ grow. With some species the mines are kept regularly spaced, rarely intercrossing unless crowded, and present a regular and pleasing patterrr; such are those of *Chramesus icoriæ* Lec., (Pl. 23, fig. 5) in hickory twigs, and *Leperisinus aculeatus* Say in ash (Pl. 5, fig. 8). With other species the larval mines are quite irregular and when numerous reduce the inner bark entirely to powder. The ends of the mines are widened to form a more or less distinct pupal cell, which may lie between the bark and the wood, may be continued into the middle layers of bark, or may be sunken below the wood surface, according to the species habit. The adult beetles finally bore round holes through the bark and escape. The result of this excavation by adults and larvæ is a set of egg-tunnels and larval-mines, characteristic of the family, frequently of the genus, and commonly of the individual species.

The tunnels of the ambrosia-beetles are discussed briefly on the following pages. They will not be confused with those cut by any other beetles of our fauna. A distinctive character is the blackening of the tunnel walls by the ambrosia fungus. The larval tunnels of *Hylecœtus* are somewhat similar and are also lined with a fungus, but they are not similarly discoloured. The tunnels of *Stenocelis* might be mistaken for those of ambrosia-beetles, but there is no staining from fungi, and the larvæ tunnel freely in the wood.

Aberrant Habits.

The tunnels of a few of our species of *Pityophthorus*, notably *ramiperda* and *puberulus*, cut their tunnels through the pith of pine twigs (Pl. 4, fig. 5). Several species of *Conophthorus* excavate egg-tunnels through the pith of pine cones (Pl. 8, fig. 5). *Hylastinus obscurus* Marsh. makes normal egg-tunnels in clover roots. A species of *Pityophthorus* cuts the egg-tunnels immediately below the wood surface of dry maple twigs, and both adults and larvæ feed upon the black wood fungi which abound in sapwood of the twigs they select. Exotic species are found in various nuts, date pits, nutmegs, jalap root, and dry twigs. Species of *Xylocleptes* breed in plants of the gourd family. Several ambrosia-beetles are recorded cutting their tunnels in the staves of wine casks

and in similar places. Aberrant habits are much more common in tropical countries than with us. The vast majority of our species breed normally in the bark or wood of trees.

Details of the Tunnels.

A study of the egg-tunnels and larval-mines reveals many important and interesting characters. A distinctive form of the galleries obtains with many species, so that an examination of the tunnels in the bark or wood may determine exactly the species to which they belong. It is thus possible to determine which species have been working in a tree, even years after the beetles have left, and if the galleries were engraved upon the wood, even after the bark has disappeared. The work of *Chramesus icoriæ* Lec. in hickory branches (Pl. 23, fig. 5), of *Leperisinus aculeatus* Say in ash (Pl. 20, fig. 2), of *Eccoptogaster piceæ* Sw. in spruce and fir (Pl. 20, fig. 3), of *E. rugulosus* Ratz. in fruit trees and wild cherry (Pl. 5, fig. 7), of *Phloeosinus canadensis* Sw. in eastern cedar (Pl. 5, fig. 5), of *Dryocoetes confusus* Sw. in mountain balsam (Pl. 19, fig. 1), and many others, may be specificially determined, even though, as rarely happens, no old dead beetles are to be found in the bark.

The Entrance-Hole.

The entrance-hole with most species is usually free from chips or frass except while this material is being extruded; but with certain other species there are peculiar characters connected with it. The boring-dust and excrement of *Xyloterinus politus* Say projects from the entrance-hole while excavation is active, often for several centimetres, as a cylindric rod of the diameter of the entrance-hole. During a period of fine weather these are often visible in great numbers on the trunks and limbs of dying, infested maples and beeches. The entrance-holes of *T. retusus* Lec., on the other hand, are readily distinguished by quite different characters. The opening is covered by a cup-like layer, an aggregation of excrement. Through a small hole in the centre of this cup, which is convex outwards, a slender thread of excrement projects, pushed out by additions from within, until finally broken by rain or by the action of gravity. The air circulation in tunnels so blocked at the entrance must be extremely slow. The borings of *Eccoptogaster rugulosus* Ratz. and *Phthorophloeus liminaris* Harris in green bark of peach trees and wild cherry trees result in a copious exudation of sap, and the hardening of the sap produces conspicuous gummy masses about the entrance-holes. The flow of resin from the tunnels of certain species of *Dendroctonus*, *Ips*, and others, in green bark of pines and spruces, results in a "pitch-tube" or "resin-tube" about the entrance-hole. The beetles are able to live in spite of the exuding resin, and by their movements backward and forward in the ejection of the boring-dust, form the surrounding tower of gum upon the bark. The presence of this "resin-tube" about the entrance-hole proves that the tunnel was started in fresh, sappy bark.

With many species of Ipid beetles the male spends part of his time backed into the entrance tunnel near the opening, which he neatly fits, and through which his declivity is often visible. In species whose males are wingless, and therefore have no part in the construction of new tunnels, the female adopts this function of guarding the entrance, in addition to her other regular duties. With a few species, like *Chramesus icoriæ* Lec., one or other of the parent adults dies in the entrance-hole, and thus prevents the intrusion of later enemies. This closing of the entrance-hole for a considerable part of the time guards in a measure from predacious and parasitic enemies, and checks evaporation from the tunnel walls.

THE ENTRANCE-TUNNELS.

The entrance-tunnels of the ambrosia-beetles pass directly through the bark and more or less deeply into the wood. There they give off side tunnels, along which the greater number of the egg-niches are cut, or in which the eggs are deposited free, according to the habit of the species.

The entrance-tunnels of the True Bark-beetles either pass directly through the bark, or in most cases traverse it more or less obliquely, to open into the nuptial-chamber or directly into the egg-tunnel within. The length of the entrance-tunnel is never great, and varies with the thickness of the bark in which the beetles are working. In the thick bark of large pine trunks, thinner places, the bark fissures, are frequently chosen for the location of the entrance-holes. Some species of ambrosia-beetles prefer to start their tunnels on freshly cut or broken surfaces. The entrance-tunnels are always perfectly cylindric, a result of the shape of the beetles and their constant revolution during the excavation. Certain species usually cut their entrance-tunnels obliquely upward, so that it is possible to tell whether the tunnels have been cut before or after the trunk has fallen.

THE EGG-TUNNELS PROPER.

The egg-tunnels of the True Bark-beetles are usually cut between the wood surface and the bark, engraving both. Certain species cut the egg-tunnel entirely within the bark. *Orthotomicus cælatus* Eichh. has this habit when working in the thick bark of mature white pine, although on branches and trunks of smaller trees its egg-tunnels engrave the wood surface more or less distinctly. The egg-tunnels of many species are almost entirely within the bark, only scoring the wood slightly; such are those of *Phlœosinus canadensis* Sw. in cedar. On the other hand the tunnels of *Chramesus icoriæ* Lec., *Leperisinus aculeatus* Say, *Pityopthorus canadensis* Sw., and many others, score the wood very deeply, and those of a few species, such as *Pityopthorus ramiperda* Sw. and *Lymantor decipiens* Lec., are almost entirely or quite below and parallel with the wood surface. Certain species of *Hypothenemus*, *Stephanoderes*, *Micracis*, and *Pityophthorus* cut their primary tunnels within the pith of twigs, and have, on this account, been termed "twig beetles." Some species of *Pityophthorus* cut their egg-tunnels usually upon the wood surface of twigs, while their larvæ frequently bore to the centre and pupate in the pith.

The egg-tunnels of the ambrosia beetles branch from the entrance tunnels in various ways, to be described in more detail under the several species in later papers. The species of *Gnathotrichus*, *Pterocyclon*, *Trypodendron*, and *Corthylus* cut their egg-tunnels at a greater or less depth below the wood surface, according to the species and particular conditions of the wood, and vary somewhat in individual habits. All the species in these genera cut egg-niches above and below along the walls of the egg-tunnels, and later even along the entrance tunnels. These niches are similar to those cut by most True Bark-beetles, and the eggs are usually packed in with boring-dust and excrement. The niches are widened and lengthened by the larvæ to form short side tunnels or "larval cradles," usually at right angles to the egg-tunnel, and only slightly longer than the larva itself (Pl. 3, fig. 8); *compound*. The egg-tunnels of *Anisandrus* and *Xyleborus* are usually merely side tunnels arising from the sides or the distal end of the entrance tunnel. The eggs, in these two genera, are deposited free in the tunnels and the larvæ live therein without cutting cradles; *simple*. The tunnels of *Xyleborus saxesceni* Ratz. are peculiar in that the larvæ excavate cavities in congress (Pl. 2, fig. 13).

It is interesting to note that certain species of the genus *Platypus* (formerly included in the Family *Ipidæ*), which occur in the southern and western portions of the continent, lay their eggs, according to Hubbard and others, free in the

tunnels, their larvæ cutting cradles similar to those excavated by larvæ of the Ambrosia beetles already mentioned, and are thus in a manner intermediate in habit between *Xyleborus* and *Trypodendron*. The only Canadian species of the genus lays its eggs free in the ends of the tunnels, and its larvæ apparently do not cut cradles.*

The tunnels and cradles of Ambrosia beetles are lined with a fungus used for food and usually characteristic of the beetle species, or at least of allied groups of species. As this subject is to be discussed in greater detail elsewhere, it is sufficient here to observe that all Ambrosia beetle tunnels are characterized by the presence of one species of these fungi during the egg-laying season, and later contain, in addition, numerous saprophytic as well as parasitic forms. The tunnel walls are invariably stained brown or black by the action of the Ambrosia fungus upon the wood.

THE VENTILATION TUNNELS.

These are short tunnels cut at intervals along the roof of elongate egg-tunnels in certain species of *Dendroctonus* and *Ips*, directed outward towards or to the outer surface of the bark (Pl. 2, fig. 3). The length of these ventilation tunnels depends upon the thickness of the bark overlying the egg-tunnel, and may vary from a millimetre, or less, to more than an inch. They serve as turning-niches and storage-places for boring-dust, and in some measure may increase the air circulation within the egg-tunnels. Many such tunnels that I have examined ended bluntly in the outer layers of bark, and could only serve as turning-niches, storage-tunnels, and to increase the body of air available for the beetles. With certain species, as *Dendroctonus simplex* Lec., the long egg-tunnel is often blocked in places with boring-dust, so that these ventilation-tunnels are perhaps useful, in such cases, for air circulation, but are certainly necessary as turning niches for the female.

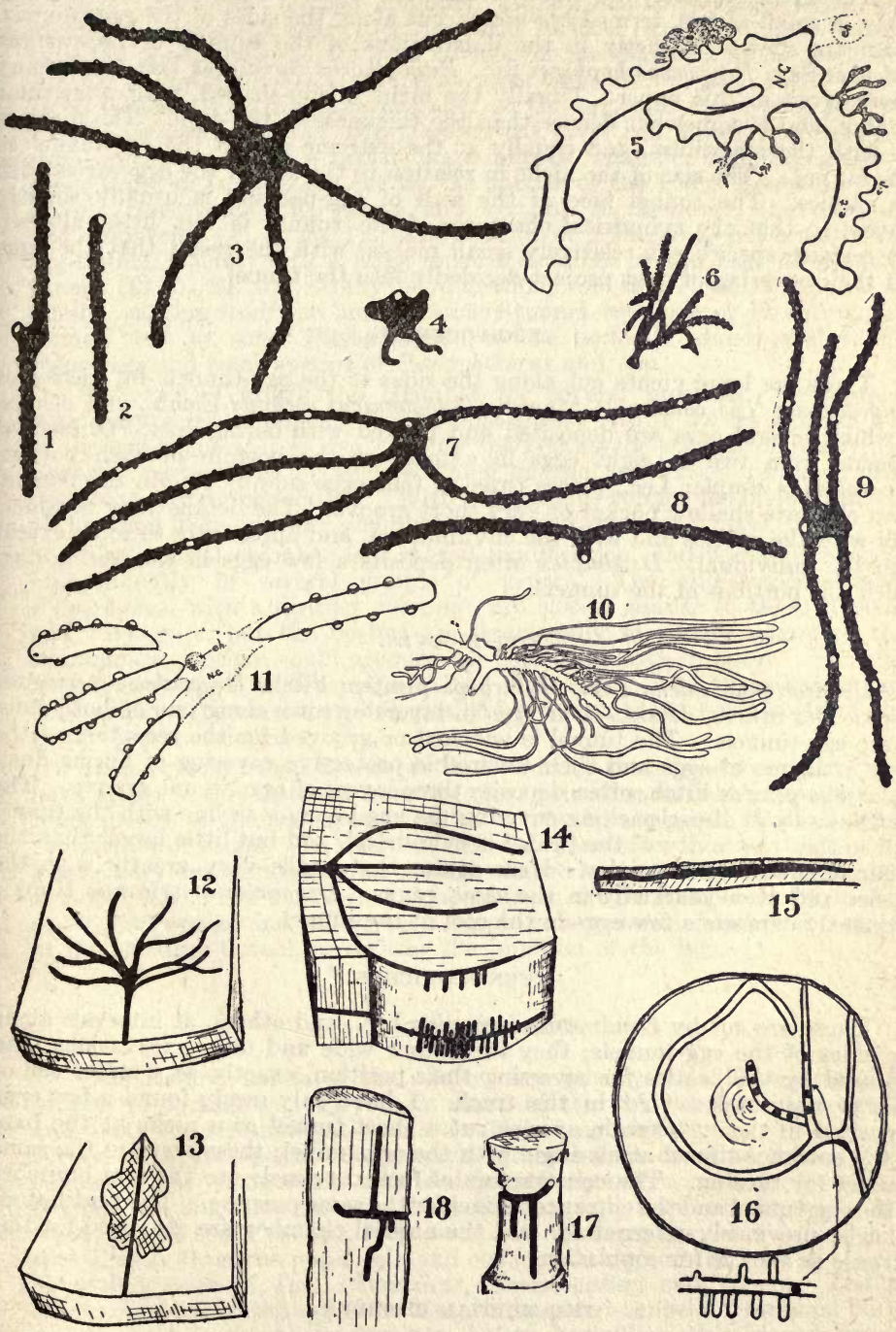
*According to Chamberlain, Or. Ag. Exp. Sta. Bul. 147, 1918, the larvæ of this species also cut cradles shortly before pupating.

PLATE 2.

TYPES OF EGG TUNNELS.

Fig. 1, Forked, longitudinal.
Fig. 2, Simple, longitudinal.
Fig. 3, Radiate, typical.
Fig. 4, Cave-tunnel.
Fig. 5, Radiate, modified; *Ips concinnus* Mannh.—e.h., entrance hole; e.p., egg-pocket; e.t., egg tunnel; l.g., larval gallery; n.c., nuptial chamber.
Fig. 6, Irregular, short.
Fig. 7, Radiate, transverse.
Fig. 8, Forked, transverse.
Fig. 9, Radiate, longitudinal.
Fig. 10, Forked transverse, with larval mines, *Phthorophloeus*.
Fig. 11, Radiate, egg-tunnels commenced, *Ips pini* Say, from below.
Fig. 12, Ambrosia tunnels, simple, horizontal.
Fig. 13, Ambrosia tunnels, compound, social gallery, *X. saxeseeni* Ratz.
Fig. 14, Ambrosia tunnels, compound, with cradles, *Pterocyclon mali* Fitch.
Fig. 15, Pith tunnels, *Micracis*.
Fig. 16, Ambrosia tunnels, compound, with cradles, *Gnathotrichus*.
Figs. 17, 18, Ambrosia tunnels, simple, vertically branched; *Anisandrus*.

PLATE 2.



EGG-NICHES.

The great majority of North American bark-beetles deposit their eggs singly in small niches, termed *egg-niches*, cut along the sides of the egg-tunnels. These are shown distinctly in the illustrations of the tunnels of *Leperisinus aculeatus* Say, *Pityogenes hopkinsi* Sw., *Pityopthorus cariniceps* Lec., and many others given in this paper. Usually the niche is cup-shaped, with a circular opening, and is somewhat deeper than the thickness of the eggs. The niche is cut with the mandibles, and usually at the extreme end of the egg-tunnel as thus far cut. The size of the niche in relation to the size of the egg varies with the species. The tunnel face of the wall of egg-packing is usually slightly convex, so that the cylindrical character of the tunnel is but little altered; but certain species cut relatively small niches, with the result that the eggs and their covering of dust project decidedly into the tunnel.

EGG-POCKETS.

These are large niches cut along the sides of the egg-tunnels by species of *Dendroctonus, Ips concinnus* Mannh., *Orthotomicus caelatus* Eichh., and others, in which several eggs are deposited and packed with boring-dust. *O. caelatus* deposits from two to eight eggs in a mass at the bottom of each pocket. *Dendroctonus simplex* Lec., places three or four eggs side by side in the bottom of an elongate shallow pocket or very short groove. The details vary considerably with the species and with the environment, and apparently to some extent with the individual. *D. simplex* often deposits a few eggs in the boring-dust which fills portions of the tunnels.

EGG-GROOVES.

Dendroctonus valens Lec., *Hylurgops pinifex* Fitch, *Dryocœtes americanus* Hopk., and others, deposit their eggs in layers or rows along one or both sides of the egg-tunnels. The tunnel is widened or grooved for the reception of the layer or layers of eggs and their invariable protective covering of boring-dust. *Hylurgops pinifex* Fitch, often deposits three layers of eggs in one groove. The continuous wall of egg-packing covering the egg layers is in line with the tunnel wall so that the cavity of the tunnel is cylindrical, and but little larger than the circumference of the beetles. Here again, the details vary greatly with the species and often markedly in the same genus. *Dryocœtes americanus* Hopk., frequently deposits a few eggs in the roof of the tunnel.

TURNING-NICHES.

These are cut by *Dendroctonus simplex* Lec., and others, at intervals along the sides of the egg-tunnels; they are rather wide and deep excavations, and are used by the beetles for reversing their position, exactly as a street car or railway train uses a " Y " in the track. I have only rarely found a few eggs deposited in them. Certain species cut a short tunnel or a niche at the base of the entrance-tunnel at an angle with the egg-tunnel; these serve in the same manner for turning. The constructors of forked tunnels use the two branches of the egg-tunnel and the entrance-tunnel for the same purpose. The ventilation-tunnels, previously referred to, and the nuptial chamber are also used for this purpose as well as for copulation.

THE NUPTIAL CHAMBER.

Many polygamous and a smaller number of monogamous species have a distinct chamber in the inner bark at the base of the entrance hole, called the

nuptial chamber, from which the egg-tunnels originate. The star-shaped tunnels of *Ips*, *Pityogenes*, *Pityophthorus* in part, *Polygraphus*, and others, have a distinctly flattened nuptial chamber, usually relatively large, either entirely in the inner bark or engraving the wood surface. In the normal star-shaped type the egg-tunnels radiate from all sides of the chamber; in the modified type cut by *Ips calligraphus* Germ., *Ips perturbatus Eichh.*, and others, the two or three tunnels arise from the chamber at the opposite upper and lower sides. The *unispinosus* group of *Eccoptogaster* cut a vertical tunnel above and below from opposite sides of a rather large nuptial chamber (Pl. 20, fig. 3). Two other types of tunnels are cut by the species of the genus *Eccoptogaster*, as at present constituted, one simple and vertical *E rugulosus*, the other forked and transverse (Pl. 4, fig. 1). The species of *Phlœosinus* cut a single vertical egg-tunnel, usually with a large nuptial chamber at the base of the entrance tunnel (Pl. 5, fig. 5). Many modifications of the chamber appear in the family, varying from the indefinite cave-tunnel with one or two irregular egg-tunnels, cut by some *Pityophthorus*, to the perfectly star-shaped tunnels of *Pityogenes* and some species of *Pityophthorus* and *Ips*.

The beetles utilize the chamber for several purposes. It serves as a temporary storage room for boring dust thrust into it by the females working in the egg-tunnels; it is also used by the beetles for turning or reversing their position, particularly by species which cut no ventilation tunnels; and it is used regularly for copulation. With polygamous species the male spends nearly all his time in the nuptial chamber and in the entrance tunnel.

The nuptial chamber is a special modification, and has apparently arisen independently in several groups of genera. The star-shaped tunnels of *Polygraphus*, with a distinct chamber, are closely similar to those of some *Ips* and *Pityogenes*; but the beetles are structurally so widely separated that no community of origin could account for their similarity in habit. The chamber is well developed in *Eccoptogaster* and *Phlœosinus*, and these genera are not only widely separated morphologically from each other but also from the two groups just mentioned.

In the genus *Pityophthorus* we find evidence that the star-shaped type may have arisen in this instance from the more primitive cave-like type still cut by some species of the genus; and the habit may be explained in allied genera by community of origin. In some species of *Dryocœtes* we find what appears to be a secondary degeneration from the star-shaped type to irregular tunnels without definite plan. The chamber has apparently arisen independently in *Eccoptogaster*, *Phlœosinus*, and others, as a simple enlargement of either the egg-tunnel or the entrance-tunnel, at or near the junction of the two.

FOOD-TUNNELS.

The feeding habits of the adults vary greatly with the species. In the process of cutting the egg-tunnels much of the excavated wood is swallowed, and many species apparently obtain sufficient nourishment in this way. Other species excavate special food-tunnels either before or after cutting the egg-tunnels. The young adults may feed extensively before emerging from the bark, cutting winding food-tunnels, "brood burrows," between the bark and the wood, as with species of *Ips*, *Pityogenes*, and others; or they may leave the parent tree directly from the pupal cell, and cut food tunnels in the bark of other trees, as with species of *Ips*, *Phlœosinus*, *Eccoptogaster*, and others. The parent adults may extend the egg-tunnels as winding food-tunnels, "terminal burrows," or cut short food-tunnels elsewhere before beginning their second set of egg-tunnels. This intermediate period of rest and feeding is needed, apparently, in order to mature the second lot of eggs.

The Types of Egg-tunnels.

The egg-tunnels present many variations in form, even in the same genus and interesting similarities in habit occur between species belonging to widely separated genera. Several arrangements for classifying the ipid egg-tunnels have been suggested. The variations in the tunnels are so numerous that a detailed classification must be cumbersome if at all complete, and the brief arrangement in the following table will perhaps be more useful for the purpose of this bulletin:—

Irregular Elongate Tunnels —*Dendroctonus, Hylurgops, Hylastes,* etc.
Irregular Short Tunnels.—*Dryocœtes* (in part), etc.
Simple Longitudinal Tunnels.—*Phlœosinus, Eccoptogaster* (in part), *Chramesus,* etc.
Simple Transverse Tunnels.—*Cryphalus, Eccoptogaster* (in part); rare.
Forked Tunnels.—Longitudinal or transverse; *Leperisinus, Pseudohylesinus, Eccoptogaster* (in part), *Phthorophlœus,* etc.
Radiate Tunnels.—*Ips, Pityogenes, Pityophthorus* (in part), *Polygraphus,* etc.
Cave Tunnels.—*Cryphalus* (in part), *Pityophthorus* (in part).
Pith Tunnels.—*Micracis, Stephanoderes, Pityophthorus* (in part).
Ambrosia Tunnels.—Simple; *Anisandrus, Xyleborus.* Compound; *Gnathotrichus, Pterocyclon, Trypodendron, Xyloterinus.* Page 11.

PLATE 3.

AMBROSIA-BEETLE TUNNELS.

Fig. 1, *Anisandrus populi* Sw.; eggs, larvæ and pupæ; 1½ times natural size.*
Fig. 2, *Trypodendron retusus* Lec.; tunnel in poplar; about natural size, showing a pupa in its cradle.
Fig. 3, *Anisandrus obesus* Lec.; tunnel in beech, showing eggs lying in the inner end.**
Fig. 4, *Trypodendron retusus* Lec.; larvæ; about natural size.*
Fig. 5, *Anisandrus pyri* Peck; tunnels in apple; about ½ natural size.*
Fig. 6, *Trypodendron retusus* Lec.; tunnels in poplar; about ⅓ natural size.
Fig. 7, *Trypodendron betulæ* Sw.; tunnels in birch; ½ natural size.
Fig. 8, *Gnathotrichus materiarius* Fitch; tunnels in pine, showing larvæ, pupa, and adult; natural size.**
Fig. 9, *Anisandrus pyri* Peck; exit holes in apple limb; about ½ natural size.
Fig. 10, *Anisandrus populi* Sw.; tunnels in poplar.
Fig. 11, *Trypodendron retusus* Lec.; tunnels in poplar, showing small larvæ.*
Fig. 12, Eggs, larvæ, and pupæ of *Anisandrus populi* Sw.; slightly enlarged.

PLATE 4.

BARK-BEETLE TUNNELS (Original.)

Fig. 1, *Eccoptogaster subscaber* Lec.,; tunnels in lowland fir; wood surface; ⅓ natural size.
Fig. 2, *Pseudopityophthorus minutissimus* Zimm.; tunnels in hazel; wood surface; natural size.
Fig. 3, *Dendroctonus monticolæ* Hopk.; pitch-tubes in western white pine trunk; much reduced.
Fig. 4, *Orthotomicus cælatus* Eichh.; tunnels in white pine bark; about natural size.
Fig. 5, *Pityophthorus nitidus* Sw.; tunnels in pine twig, on the wood surface and in the pith; ½ natural size.
Fig. 6, Study-tunnels, covered with sheet celluloid.
Fig. 7, *Phthorophlœus piceæ* Sw.; tunnels in white spruce branch; ½ natural size.
Fig. 8, *Orthotomicus caelatus* Eichh.; tunnels in white pine, inner surface of bark, showing inner bark entirely reduced to powder.
Fig. 9, *Dendroctonus borealis* Hopk.; tunnels in white spruce, inner surface of the bark; (the right end of the figure should be uppermost, the (black) egg-tunnels vertical); the larvae feed in congress at first and finally separate to cut individual mines; much reduced.
Fig. 10, *Ips perturbatus* Eichh.; tunnels in white spruce bark; ⅓ natural size.
Fig. 11, *Eccoptogaster subscaber* Lec.; tunnels just commenced in balsam; ½ natural size.
Figs. 12 and 13, *Pityogenes hopkinsi* Sw.; tunnels in white pine limb; ⅓ natural size.

*Original **Author's illustration

PLATE No. 3.

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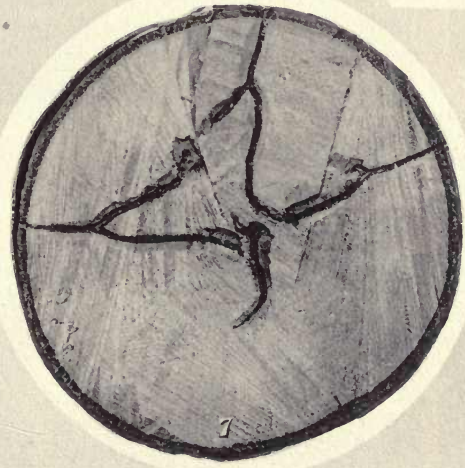
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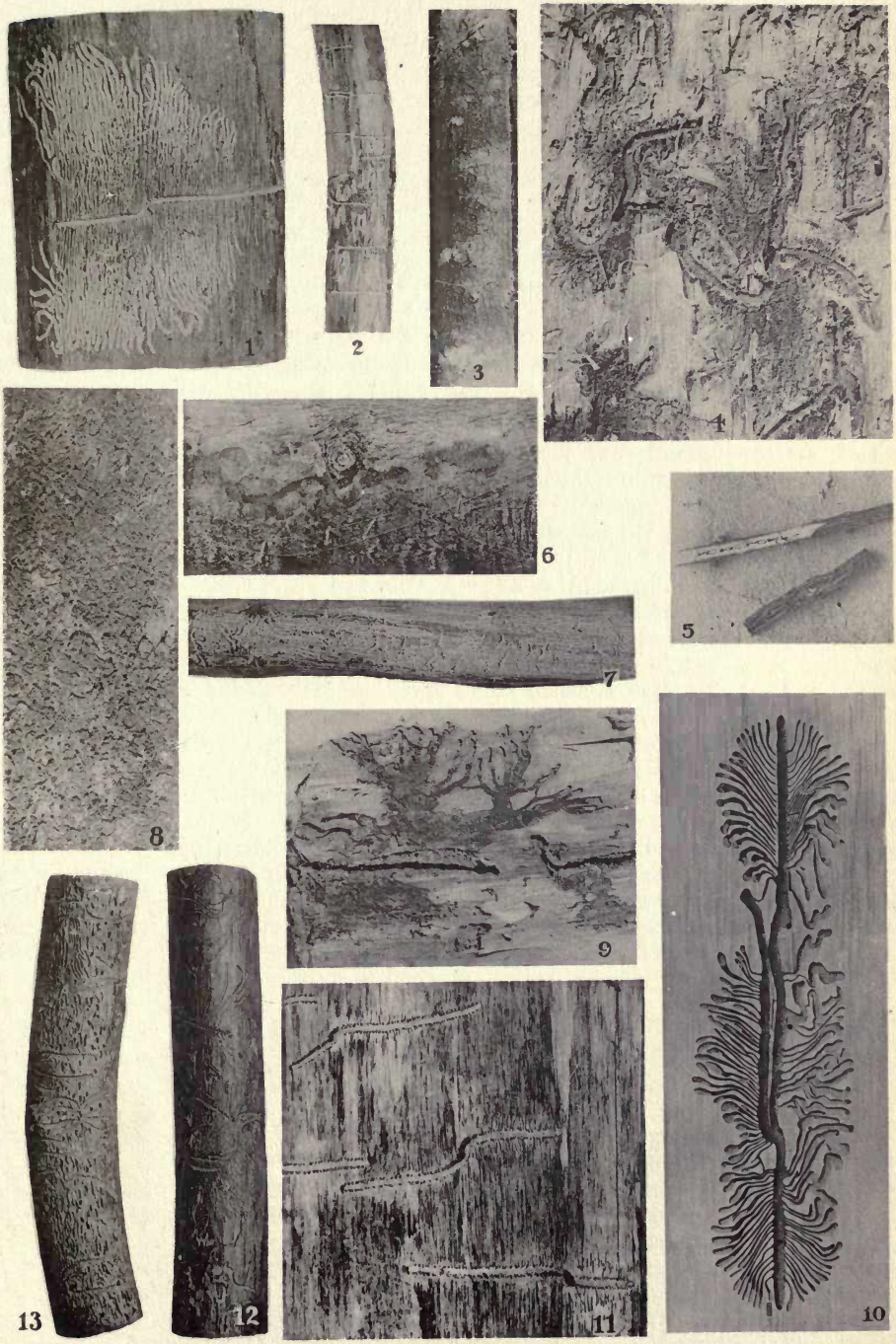
PLATE No. 4.



Irregular Elongate Tunnels.—The egg-tunnels of *Dendroctonus*, *Hylastes*, and *Hylurgops* are elongate, longitudinal, variably irregular, branched or winding, and frequently anastomosed.

Irregular Short Tunnels.—Several species of *Dryocœtes*, and others, cut short irregular tunnels.

Simple Longitudinal Tunnels.—These are simple tunnels lengthwise of the grain, moderately short and straight. They may or may not have a nuptial-chamber or turning-niche at the base of the entrance-tunnel, but they have no ventilation tunnels or turning-niches along the sides. *Phlœosinus dentatus* Say cuts a rather elongate egg-tunnel with a distinct nuptial-chamber. *Eccoptogaster rugulosus* Ratz., and *E. 4-spinosus* Say, cut shorter, simple tunnels without a distinct nuptial chamber. *Eccoptogaster piceæ* Sw., cuts an entirely different one; here the entrance-tunnel opens into a large nuptial-chamber, which gives off, above and below, but not opposite to each other, a longer or shorter egg-tunnel. *E. unispinosus* Lec., of the Pacific Coast, has tunnels very similar to those of *piceæ*; these are properly of the forked type. *Chramesus icoriæ* Lec. cuts short longitudinal egg-tunnels with a distinct turning-niche at the base of the entrance-hole. Individual tunnels are frequently more or less oblique.

Simple Transverse Tunnels.—These are cut by very few of our species, except as individual variations from a different type.

Forked Tunnels.—In this type, as here defined, the entrance-tunnel opens into two egg-tunnels, usually somewhat curved, and diverging at a very wide angle, or nearly in line. Apparently this type has been developed by the extension of a turning-niche, such as is now cut by *C. icoriæ* Lec., into a second egg-tunnel. The tunnels of *Phthorophloeus piceæ* Sw. (Pl. 4, fig. 7), illustrate well the transition from the simple egg-tunnel with a turning-niche into a regular forked type. In this species an egg-tunnel is cut from the base of the entrance-tunnel, usually nearly transverse, though frequently oblique, and a second much shorter egg-tunnel is cut from the base of the entrance-tunnel at a varying, though usually wide angle with the first; or in other words, the turning-niche has been extended somewhat and a few egg-niches cut on either side. The tunnels of *Phthorophloeus liminaris* Harris (Pl. 5, fig. 7) are usually well-developed, with two egg-tunnels, one often somewhat longer than the other, nearly in line, and slightly incurved to meet at the base of the entrance-tunnel. The latter is oblique and its base slightly engraves the wood at its junction with the two egg-tunnels. In the process of their development the tunnels of *liminaris* have probably passed through the stage in which we find those of *piceæ* to-day. *Leperisinus aculeatus* Say cuts somewhat similar egg-tunnels in ash, but the two branches are rather more distinctly arched from their junction with the entrance-tunnel. The tunnels of *Hylurgopinus rufipes* Eichh., in elm, are of the same type (Pl. 5, fig. 6). The species cutting the tunnels thus far described are usually monogamous.

The tunnels of *Pseudopityophthorus minutissimus* Zimm. are peculiar, straight and transverse, but crossed near the middle of their length by a short vertical tunnel. They may be included under the simple transverse tunnels (Pl. 4, fig. 2).

Radiate, or Star-shaped Tunnels.—These are cut by the genera *Ips*, *Pityophthorus* (in part), *Pityogenes*, *Pityokteines*, *Polygraphus*, and others. The entrance-tunnel opens below into a flat nuptial-chamber lying between the bark and the wood, or often chiefly in the former. From the sides of this cavity the egg-tunnels radiate in varying number, according to species and individuals, from three or four to eight or nine. The species cutting these tunnels are polygamous and each egg-tunnel is cut, usually, by a separate female, while a single male cuts and occupies the nuptial-chamber. The tunnels of *Orthotomicus cælatus* Eichh. are roughly star-shaped, with the nuptial-chamber entirely in the bark

(Pl. 4, fig. 4). The tunnels of *Dryocœtes* are in some species, *affaber*, variably irregular, but are in others, such as *confusus* Sw., distinctly of this type.

Certain species of *Ips* and *Pityophthorus* have a preference for following the grain of the wood, and in some of these a few very long egg-tunnels are developed, more or less parallel to each other throughout much of the length, as with *Ips calligraphus* Germ., and *Ips perturbatus Eichh.* (Pl. 4, fig. 10). Certain species of *Pityogenes* and *Pityophthorus* cut elongate egg-tunnels in the bark of small twigs, and show a more or less distinct spiral arrangement.

Cave Tunnels.—Species of the genus *Cryphalus* excavate an irregular cavity in the bark, engraving the wood, in which the eggs are deposited (Pl. 23, figs. 6, 7). *Pityophthorus opaculus* Lec., and others, have a very similar habit, sometimes combining the cave type with short irregular egg-tunnels.

Pith Tunnels.—Certain species of *Pityophthorus* ,*Stephanoderes* and *Micracis* cut their egg-tunnels through the pith of twigs (Pl. 4, fig. 5).

The Larval Mines.

The larval mines of the bark-beetles have been described briefly on page 9, and are dealt with in detail under their respective species in the remaining parts of this series.

Factors Influencing the Development of Bark-beetles.

It is very noticeable that at different altitudes and latitudes and in different seasons the broods of the Ipidæ develop at different rates. A species which is single-brooded in northern Canada may have two broods in the middle or southern States. Certain species which have normally two broods, may have but one or only a partial second brood in cold, wet seasons, in the same locality. In the same locality, and during the same season, over-wintered individuals may appear from cold, swampy sections or northern slopes several weeks later than others of the same species, which have wintered in a sunny situation. It is evident that the factors which influence the development of the larvæ and the time of appearance of the adults are of great interest, and are of particular importance in economic studies. The chief of these factors are the moisture content of the air in the tunnels, the temperature of the air and of the bark ,and the sunlight. The beetles are particularly sensitive to any change in humidity; they will leave all other activities to fill any openings made in the tunnel roof.

Valuable experimental studies upon the effect of different degrees of heat and moisture upon the development of bark-beetles have been made by several European writers, expecially by Hennings upon *Ips typographus* Linn. The results of these studies agree on the whole with more general observations made in our forests under natural conditions. It has been a matter of common observation in Canadian forests that the greater number of our bark-beetles breed most rapidly in hot weather with a moderate supply of moisture. On the other hand, broods developing in the bark in the open sunlight of clearings are not uncommonly destroyed by the high temperature and dryness of the bark, which render the latter unfit for food, and also directly affect the life processes of the larvæ. It may be noticed in very hot, dry seasons that while broods in the thin bark exposed to the open sunlight may be partly or largely destroyed, those breeding in the thick bark of the trunk or moister stump, or in thick bark about the edge of the clearing, where the moisture has been partly conserved by the shade, may breed successfully and with great rapidity. It appears also that sunlight, aside from temperature, has a stimulating effect upon growth. Hennings refers to a " heat paralysis " of the larvæ which was noticed sometimes at 24°C. dry (55 per cent to 56 per cent air moisture). The highest life processes were reached just before that point. The addition

of moisture raised the " heat paralysis " point, and so gave opportunity for more rapid development.

It is also well known that their development is retarded by periods of wet weather, such as prevailed in Central and Eastern Canada during the spring and much of the summer of 1912. Such periods of excessive humidity are, with us, invariably cold, so that we have both retarding influences in operation. There is also the important factor of fungus development which is so much more rapid in wet seasons, and both renders the bark unfit for food and at times destroys all stages of the beetles in large numbers.

We may safely conclude that warm and moderately dry seasons, with abundant sunlight, are the most favourable for bark-beetle development; and that cold and wet seasons are the most unfavourable.

Mating Habits.

This subject is treated in parts of this series dealing with the biology of the species, planned for later publication. With many species copulation takes place during the migratory flight from the old trees to the new, either on the bark of the old trees or after alighting. With *Anisandrus*, in which the males are unable to fly, paring takes place at the mouth of the old tunnel or possibly within it, but probably in most cases on the bark of the trunks containing the old tunnels during the later summer. Monogamous species pair often at the mouth of the new tunnel and one mating may be sufficient to fertilize the greater part of one lot of eggs; polygamous species usually mate at the entrance from the nuptial chamber into an egg-tunnel, and with these species mating occurs frequently.

The Oviposition.

With many species, oviposition takes place in the manner described for the following two. The oviposition of *Pityogenes hopkinsi* Sw. was observed. The egg-niche was cut at the extreme end of the egg-tunnel, and when the tunnel was examined, the female was in the tunnel end with ovipositor inserted into the niche. In a few seconds the egg appeared and adhered to the bottom of the niche. The time of passage was about one second. As soon as the egg was deposited the female moved forward to the nuptial-chamber, reversed her position, and entered the tunnel head foremost. When she reached the tunnel end she appeared to move the egg with the mandibles, probably placing it more evenly, and then turned her attention to filling a crack in the tunnel roof with boring dust. The tunnel had been previously opened and covered with sheet celluloid, so that the beetles within could be watched, and the celluloid had been moved just previous to oviposition. Some of this dust she pushed in from the nuptial-chamber (the male had been removed and the nuptial-chamber was partly filled with boring-dust), and the rest she removed from the tunnel end. This finished, she continued the excavation of the tunnel, placing the boring-dust thus obtained about the egg until the niche was filled.

The *Dendroctonus simplex* female cuts its short egg-groove or egg-pocket at the extreme end of the tunnel as then cut. It then backs out to the nearest turning-niche, or possibly ventilation-hole, reverses its position, proceeds backwards to the end of the tunnel, and inserts the tip of the abdomen into the egg-pocket. In one case observed by the writer, the tunnel end was opened, revealing the female in position for ovipositing. She remained in that position, almost motionless, for six minutes, until, suddenly, the egg appeared, or rather, as the ovipositor was placed against the bottom of the pocket, and the egg was large, the beetle appeared to walk away from about the egg, leaving the latter adhering to the wood. The female then moved forward to the nearest turning-

niche, reversed her position, and advanced head foremost into the tunnel to continue excavation and cover the egg with boring-dust. As the tunnel was by this time covered with celluloid, she first proceeded to close the cracks between it and the edges of the tunnel with boring-dust.

Removing the Boring-dust.

In removing the boring-dust, the female scrapes it backward with the mandibles, which make a very efficient hoe. If she wishes to pack boring-dust into egg-niches or to fill cracks in the tunnel wall, the dust is pushed forward with the mandibles and packed by them into the proper position, but when ejecting boring-dust from the tunnel it is always scraped backward, first with the mandibles and then with the legs, working it beneath and behind the body. By moving backward and at the same time revolving in the tunnel, the insect is able to remove the dust without difficulty, and to eject it into the nuptial-chamber, or to extrude it through the exit hole. The tarsi are retracted more or less, and the outer edge of the tibiæ is used much in locomotion, and particularly in removing the boring-dust. The armature of the tibiæ, of course, assists considerably in both operations.

A Method for Studying Habits.

(Pl. 4, fig. 6).

In studying the habits of Ipidæ, it becomes necessary to devise some method of watching the beetles at work. All their operations, with the exception of cutting the entrance-hole, are performed beneath the protecting cover of bark; and when the latter is largely removed they invariably cease work almost immediately and either leave the tunnels or retire to the uncovered portions. If the tunnels, with the beetles in them, are covered in the proper way with glass, celluloid, or mica, the excavation may be continued and much of the work may be observed. We have secured best results with smaller species working in thin bark, such as *P. hopkinsi* Sw., by removing the bark over the nuptial-chamber and a part of an egg-tunnel, and immediately pinning thereover

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PLATE 5

BARK-BEETLE TUNNELS (Original).

Fig. 1, *Pityokteines sparsus* Lec.; egg-tunnels in balsam fir; wood surface; twice natural size.
Fig. 2, *Dendroctonus obesus* Mannh.; tunnels in Sitka spruce bark; very much reduced.
Fig. 3, *Pityophthorus canadensis* Sw.; Pupal cells in pine, showing larva and pupa in position; about natural size.
Fig. 4, *Hylastinus obscurus* Mannh.; tunnels in red clover roots, showing a beetle, and the eggs in place in the niches; about natural size.
Fig. 5, *Phloeosinus canadensis* Sw.; tunnels in arbor vitae, wood surface; two-thirds natural size.
Fig. 6, *Hylurgopinus rufipes* Eichh.; tunnels in elm, inner surface of bark; about natural size.
Fig. 7, *Phthorophloeus liminaris* Harr.; tunnels in peach limb, showing a portion of the brood; one-half natural size.
Fig. 8, *Leperisinus aculeatus* Say; tunnels in ash, showing the brood in position; about natural size.
Fig. 9, *Pityophthorus nudus* Sw. tunnel in pine, wood surface; twice natural size.
Fig. 10, *Pityophthorus canadensis* Sw.; pupal cells in pine twig, showing full grown larvæ and pupae; natural size.
Fig. 11, *Phloeosinus canadensis* Sw.; tunnels in arbor vitae, showing eggs in situ; one and one-fourth natural size.

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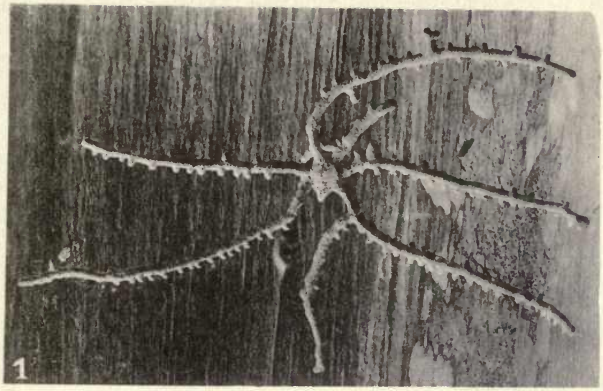
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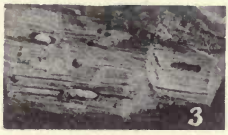
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a piece of sheet-celluloid, leaving a very small opening at one side of the nuptial-chamber for ventilation and the extrusion of the boring-dust. Better results are obtained with but one egg-tunnel, since in sets with several working females more dust is pushed into the nuptial-chamber than the male can handle under the abnormal conditions, and the chamber rapidly becomes blocked. With such an arrangement one may observe the removal of the boring-dust and its extrusion from the nuptial-chamber, the feeding habits of the male, copulation, and the reversal of position of the female before and after egg-laying. If the roof of the egg-tunnel is rapidly and carefully removed immediately after the female has been observed to back into the tunnel, the process of egg-laying may be studied. A bit of sheet-celluloid should be placed over the tunnel as soon as it is opened.

When the bark is thick, and the tunnels chiefly in the inner bark, the following method may be used with advantage. The bark is carefully removed from the wood, leaving the nuptial-chamber and the developing egg-tunnel as nearly uninjured as possible, with the beetles within them. A small sheet of moderately thick glass is placed over the inner side of the bark, closing in the tunnels. The glass should be held firmly in place by rubber bands or other means. When the tunnels are not under observation, the bark should be kept glass downwards upon dark cloth and weighted moderately with a block of wood to prevent warping.

Whether celluloid or glass is used to cover the tunnel, the male will immediately proceed to fasten all cracks about the edges of the chamber with boring-dust, and the female does the same in the egg-tunnel; excessive evaporation from the opened tunnels is thus somewhat checked. It is necessary to remove the glass or celluloid from time to time and clean away the boring-dust which has become attached to it.

The moisture content of sticks used in breeding experiments may be preserved to some degree, while the bark is intact, by coating the cut ends with melted paraffin.

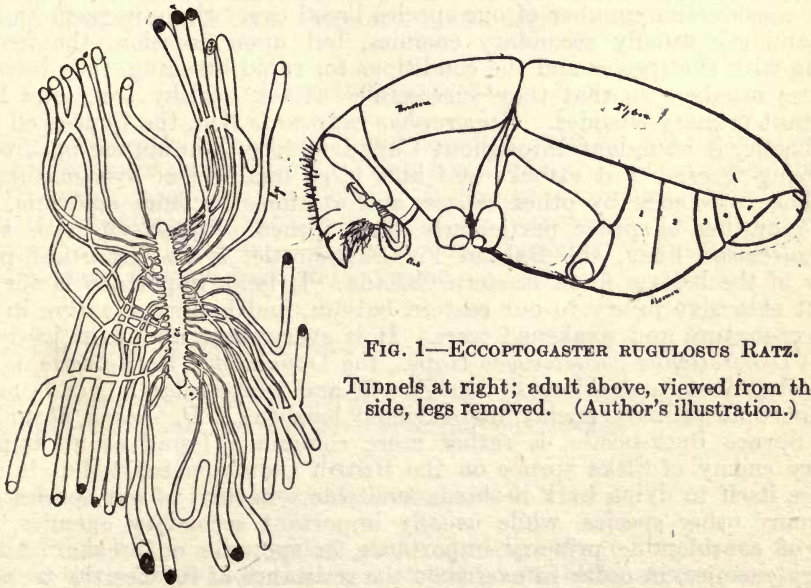

FIG. 1—ECCOPTOGASTER RUGULOSUS RATZ.

Tunnels at right; adult above, viewed from the side, legs removed. (Author's illustration.)

II.

BARK-BEETLE INJURIES AND THE MEANS OF CONTROL.

Bark-beetle Injuries.

The majority of our bark-beetle species breed commonly in dying trees and slash, but many of these attack trees which have become weakened or unthrifty, or even at times healthy trees, and they are therefore distinctly injurious. Other species attack healthy trees readily when the beetles are present in sufficiently large numbers, and have killed an enormous quantity of timber in Canadian forests.

The injury to living trees is caused by the adult beetles cutting their egg-tunnels through the inner bark or upon the surface of the sap wood, and by the larvæ excavating the larval-mines in the same location.

The multitude of tunnels and mines checks the flow of sap and rapidly kills the tree, or the part of it attacked. Direct injury to the timber is caused by the Ambrosia-beetles, since their small black tunnels penetrate the wood for several inches or, in some cases, for more than a foot.

PRIMARY ENEMIES.

Certain of our bark-beetle species are commonly found attacking and killing heal hy timber. They attack perfectly sound trees and cause the chief or primary injury, and they are therefore known as "primary" enemies. Among our best known examples are: *Dendroctonus brevicomis* Lec., *D. monticolæ* Hopk., *D. piceaperda* Hopk., *D. borealis* Hopk., and *Dryocœtes confusus* Sw. These are also found breeding in slash, and in timber dying from various causes, but they are commonly and abundantly found attacking healthy timber in quantity.

A considerable number of our species breed everywhere in slash and dying trees and are usually secondary enemies, but upon occasion, the frequency varying with the species and the conditions for rapid breeding, they increase to immense numbers so that they successfully attack healthy trees and become important primary enemies. *Polygraphus rufipennis* Ky., the Four-eyed Spruce Bark-beetle, is abundant throughout Canadian forests in spruce bark of slash and dying trees; but it attacks and kills large numbers of over-mature trees, and those weakened by other causes, and at times becomes epidemic, killing large quantities of spruce, particularly black spruce. *Pityokteines sparsus* Lec., (*Ips balsameus* Lec.), the Balsam Fir Bark-beetle, is an important primary enemy of the balsam fir in Eastern Canada. It is an important factor in the present extensive injury to our eastern balsam, and is always active in killing the over-mature and weakened trees. It is everywhere abundant in dying fir bark. *Dendroctonus pseudotsugae* Hopk., the Douglas Fir Bark-beetle, is everywhere abundant in slashings of Douglas fir and western larch, but is at times an important primary enemy in restricted localities. *D. obesus* Mannh., the Sitka Spruce Bark-beetle, is rather more commonly found as an important primary enemy of Sitka spruce on the British Columbia coast, but it usually confines itself to dying bark if this is available. Several of our species of *Ips*, and many other species, while usually important secondary enemies, are at times of considerable primary importance in sporadic outbreaks. All these primary enemies, in order to overcome the resistance of the healthy trees, must attack in very large numbers, so that their numerous and rapidly excavated tunnels may check the sap flow in a short time. In an epidemic outbreak of

the Western White Pine Bark-beetle in western yellow pine more than 2,000 pairs of beetles were estimated cutting their egg-tunnels in the trunk of one tree. On the other hand, many examples of abandoned tunnels of various species are found, indicating that the beetles have entered the bark individually or in small numbers, and have been overcome or driven away by the excessive and sustained flow of resin.

SECONDARY ENEMIES.

The majority of our bark-beetles are found breeding in bark of dying trees and logs. Many of them readily attack weakened trees or those which have been injured by fire, primary bark-beetle attack, or other causes, and rapidly effect the death of the trees. They are therefore injurious in the sense that they assist other agencies in killing timber, without themselves attacking healthy trees, and are known as "secondary" enemies. Some of these species, usually secondary, when they become exceedingly numerous through favourable opportunities for breeding, do at times become primary and attack nearby healthy timber to a varying degree, causing local sporadic outbreaks. Some of the more important of these species have been mentioned in the preceding paragraph.

A few of our species normally attack healthy trees in individual pairs, and while their young may succeed in developing, only the part of the tree directly affected receives any serious injury. *Dendroctonus valens* Lec., the Red Turpentine Bark-beetle, often kills patches of bark at the base of pine and spruce without killing the trees outright. This species is responsible, however, for the death of considerable numbers of yellow pines in British Columbia, and is an important assistant of the Western White Pine Bark-beetle and the Western Pine Bark-beetle in the epidemic outbreaks.

Several species of *Pityophthorus* kill twigs of pines in considerable numbers. Species of *Phlœosinus* and *Eccoptogaster* cut food tunnels in the twigs of their host trees, causing more or less injury thereby.

Several secondary species of the genera *Polygraphus*, *Eccoptogaster*, *Pityogenes*, *Pityophthorus*, and others, hasten the death of the lower branches of pine and spruce, and to that extent may in a sense be considered *beneficial* in helping to produce cleaner trunks and, therefore, better logs.

NEUTRAL SPECIES.

Many bark-beetle species are found breeding only in dying bark and are not known to cause any injury to living trees. *Leperisinus aculeatus* Say, in ash; *Chramesus icoriæ* Lec., in hickory; *Hylurgopinus rufipes* Eichh., in elm; and *Pseudopityophthorus minutissimus* Zimm., in branches of oak and beech, are not known to injure living trees in our woods. *Lymantor decipiens* Lec., and a few others, breed in dead bark and sapwood.

The Importance of Bark-beetle Injuries in Canadian Forests.

These injuries include the normal annual loss to weakened trees, minor sporadic outbreaks, and the extensive epidemic outbreaks.

THE NORMAL ANNUAL LOSS.

In addition to the more evident outbreaks where large numbers of trees die each year in the infested area, there is a very large and often unrecognized annual loss due to the normal activities of forest insects. Everywhere throughout the forest, injured, unthrifty, and overmature trees are attacked and killed by

various species of bark-beetles and wood-borers; and the normal loss from this cause is so very great, when large areas are considered, that it should receive serious consideration. When coniferous trees die without any apparent external injury, examination usually shows that their death has been hastened or caused by bark-beetles or other insects. When slashings are allowed to lie, the fresh bark and wood serves as a breeding ground for many destructive insects, and it is therefore only to be expected that the annual crop of scattered dying trees will be abnormally large in the neighbourhood of bodies of neglected recent slash. It unfortunately happens that nearly all these scattered dying trees are completely destroyed by boring beetles during the few years following their death, and they become an absolute loss; since, even though the limit is being logged, it is often considered unprofitable to collect the scattered dying trees. Properly conducted slash burning will almost invariably reduce the amount of this annual loss, and it must be regarded as a most valuable method of insect control.

SPORADIC OUTBREAKS.

From time to time small local bark-beetle outbreaks occur usually in the neighbourhood of slash from cuttings, wind falls, or fire-killed timber. The beetles concerned are frequently common secondary species, which, having had suitable opportunities for rapid breeding, find themselves numerous enough to attack the nearby green timber successfully; these have already been referred to under "Secondary Enemies," page 23. These minor outbreaks are easily controlled, and may die away without causing extensive injury; on the other hand, if they have been originated by some of the more destructive species, they may become epidemic, and devastate the whole countryside. Small outbreaks by a destructive primary enemy should not be disregarded.

EPIDEMIC OUTBREAKS.

Bark-beetle outbreaks may be considered epidemic when they spread rapidly over a wide area, involving the death of many hundreds or thousands of trees. Under these conditions the beetles occur in immense numbers, and attack the green timber with the greatest readiness. Often the largest and finest trees are selected. The one or more primary enemies really responsible for the spread of the injury are accompanied invariably by numbers of secondary species. Many examples of these extensive injuries have occurred in Canada and the United States during the last century. The Destructive Eastern Spruce Bark-beetle, *Dendroctonus piceaperda* Hopk., has killed many millions of feet of spruce timber in Maine and New Brunswick during a series of destructive outbreaks, the last of which occurred between the years 1897 and 1900. The best known Canadian examples are those still spreading in the yellow pine in southern British Columbia, caused by the Western Pine Bark-beetle and the Western White Pine Bark-beetle, and those in the western white pine and

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PLATE 6.

BARK-BEETLE BREEDING GROUNDS (ORIGINAL).

Fig. 1, A slashing on Vancouver Island; an ideal breeding ground for beetles.
Fig. 2, Beetle-killed yellow pine, Indian Meadows, B.C.
Fig. 3, Beetle-killed western white pine, B X Mountain, B.C.; the dead trees were killed by the Western White Pine Beetle many years ago.
Fig. 4, Beetle-killed lodgepole pine, Trepanier Creek, B.C.

PLATE No. 6.

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lodgepole pine caused by the Western White Pine Bark-beetle. In parts of the infested country the trouble commenced nearly twelve years ago, and practically all the pines have been killed (P. 6, figs. 2, 3, 4). Injury to the mountain balsam by the Destructive Western Balsam Bark-beetle, *Dryocœtes confusus* Sw., is sporadic in many localities over a wide area between Lesser Slave lake and the main line of the Canadian Pacific railway through the Rockies and Selkirks, but in certain districts it may be considered epidemic.

Conditions Favouring Bark-beetle Outbreaks.

In addition to the weather, latitude and altitude, there are various local conditions which favour the rapid development of the beetles, and, therefore, are directly concerned in the origin of sporadic and epidemic outbreaks.

SLASH.

The refuse from cutting operations, culls, branches, tops, and stumps affords an ideal breeding-ground for practically all our injurious bark-beetles as well as for many other injurious species. Logging operations, settlers' clearings, and even cuttings for firewood and for trail-making, provide slash that may prove a positive menace to the surrounding healthy timber.

In order to control our destructive bark-beetles it is only necessary to reduce the numbers so that the normal amount of dying bark to be found in the woods will suffice for breeding purposes. Apparently all our bark-beetles have, normally, a preference for dying bark; and it is only when their numbers are very great that green timber is attacked in quantity. It therefore follows that so long as extensive cutting in a district continues, the slash and stumps serve as a breeding-place, and to a considerable extent, or for a time often entirely, protect the healthy trees from most species of beetles. Broods of our most injurious species which have bred in an epidemic outbreak in green trees have apparently a decided tendency towards green timber. Unless the amount of slash increases from year to year, certain species are bound to develop to such numbers that additional breeding-places are required, and then, or, with certain species, apparently before that stage is reached, they attack the surrounding green timber. When cutting ceases suddenly there is always danger that an outbreak may develop in the neighbourhood.

It is therefore evident that while slash may serve for a longer or shorter time as a partial protection to the standing timber, it is likely to become a nuisance, since it offers an abundant food supply for the beetles in which they may breed to immense numbers.

The slash can be made to serve as an effective trap. Many injurious species will pass the winter chiefly as young adults or larvæ in the bark. If the slash of the previous summer's cutting is burned during winter and early spring, a sufficient number of the beetles will usually be killed to hold the injurious species in check. When there is but one brood each season, as with the Mountain Pine Bark-beetle, winter burning of slash of the previous winter's cut will be effective. When species with two broods are involved summer slash burning in early August, of the previous winter's cut, would assist in their control. The most important consideration, however, is the destruction of the slash by fire before the beetles can breed in it and emerge to infest nearby timber. Properly conducted slash burning will be exceedingly effective in averting injuries by both forest insects and fungi.

GROUND FIRES.

Light burns also provide an abundant supply of dying bark for breeding purposes. The injured and slightly burned trees are in some cases as dangerous

beetle breeding grounds as the slash, and this should be considered when the burns are being logged. If the fire has occurred in the first half of the season and has charred only the bark near the ground, the timber on a burn must be cut during the first winter following the fire, or not later than the second winter, if anything is to be saved from the grubs of the large wood-borers.* Since the logs will contain these living grubs, even though cut the first winter after the fire, they must be got into water or sawed before spring opens; and when the latter is done the lumber should be dried as rapidly as possible. All green slash and small dying trees on the burn should be piled and burned to prevent the breeding of bark-beetles and other insects. Trees which have been thoroughly charred from base to top may be disregarded in so far as beetle control is concerned. Burns which were made late in the season are, of course, frequently immune from beetle injury, although this is true to a smaller degree in British Columbia than in Eastern Canada.

OTHER FACTORS.

Wind-falls, snow-breaks, and flood injuries provide more or less dying timber for beetle breeding grounds each season, particularly in the mountain sections. Whenever any extensive injury of this kind occurs in government parks or reserves, or on valuable private holdings, it is desirable to have the dying timber utilized or destroyed before it can give forth its crop of destructive beetles.

Natural Control Factors.

The influence of weather conditions upon the broods has already been discussed. The other natural agencies operating to check the development of the beetles in our forests are, parasites of various kinds, predacious insects, birds and fungi.

PARASITES.

Small hymenopterous parasites deposit their eggs on the larvæ or near them in their tunnels, and the young parasites kill the beetle larvæ by feeding upon their body juices (Pl. 19, fig. 2). The larger of these parasitic species deposit their eggs through the thin bark overlying the larval mines in the tops and branches; the minute species enter the egg-tunnels and lay their eggs often in the egg-niches. They affect different species of bark-beetles in varying degrees. The most destructive bark-beetles, breeding in heavy, thick-barked timber, are but little affected by them. On the other hand, some species, such, for instance, as *Leperisinus aculeatus* Say, are frequently very heavily parasitized, and the minute round holes through which the adult parasites eventually emerge from the bark are often thickly interspersed with the exit-holes of the beetles. A few of our species are sometimes heavily parasitized by mites which breed in the mines and destroy the larvæ about the time of pupation.

PREDATORS.

Predacious beetles and their larvæ are frequently abundant about and within the egg-tunnels and mines, and feed upon the bark-beetle adults, their eggs, and the larvæ.

The influence of parasites and predacious insects appears, on the whole, to be of minor importance in controlling bark-beetles in our forests; although it is possible that some of our secondary species, normally rather heavily parasitized, might otherwise be of primary importance.

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*Except the largest timber of the Pacific Coast.

BIRDS.

Insectivorous birds, particularly the woodpeckers, are decidedly beneficial in destroying the broods of bark-beetles whenever their numbers are sufficiently great. Beetle-infested trees are often found with the bark largely riddled by woodpeckers, and the broods almost entirely destroyed. In the beetle-infested yellow-pine area of southern British Columbia the woodpecker work is sometimes strikingly evident, and the beetle trees may often be detected in this way (Pl. 7, fig. 4). There is evidence that the birds have at times a decided effect in reducing the numbers of the beetles over a limited area; but while their influence on the whole is decidedly beneficial, they are probably never sufficiently numerous in our woods to control more than very small sporadic outbreaks.

PARASITIC FUNGI.

The effect of parasitic fungi in destroying broods of bark-beetles has been studied in several instances. This factor appears to be of minor importance in our forests.

METHODS OF CONTROL.

Sporadic outbreaks by bark-beetles may usually be controlled without great difficulty; and even epidemic outbreaks, in which many hundreds of trees are dying, may be brought under control, often with very little actual loss. The peculiar habits of the beetles render them vulnerable to attack by the only methods the lumberman could feasibly employ. Our most destructive species have one brood, or one brood and a partial second one, each season; they pass the winter as adult beetles and larvæ in the bark of the dying trees, entered by the parent adults in the early part of the same season. When in green timber the broods always pass the winter in the trees attacked by their parent beetles earlier in the same season, then usually with yellowing foliage and often with resin-tubes and woodpecker work showing on the bark of the trunk. The beetles never return to the old "red-tops," as the affected trees are called, nor remain in the trees longer than one year. If then, by modified logging operations, these green "beetle trees" can be removed during winter, kept separate, and so treated that the broods in the bark will be killed before their breeding season opens, it is possible to stop the outbreak in one season. If *all* the green beetle-trees could be treated and all the slash and broken trees burned it would be possible, at least in theory, to exterminate the injurious species from a limit in one winter's work. Practically, this would not be possible in dealing with an outbreak of any extent; but it is fortunately unnecessary. If over three-fourths of the broods in the infested trees can be killed before they emerge in the early season, the outbreak can be checked; and by similar work upon the relatively few trees attacked the succeeding season, it can be brought under nearly complete control, provided the entire infested section is treated, so that there will not be extensive reinfestation each year. The largest and most heavily infested trees and the most heavily infested sections should receive special attention. When only a portion of the infestation can be treated each season, it is usually considered advisable to direct the work towards reducing as rapidly as possible the chief centres of infestation in the whole infested section. What portion of the second year's work should be employed in new territory, and how much towards cleaning up more completely on the ground covered during the previous winter, must be decided by the conditions of the locality. The details of the control methods will depend upon the species of beetles involved, and partly also upon local conditions, and should be undertaken with the direction of a competent forest entomologist.

When it becomes necessary to undertake direct control measures, the broods in the bark of the infested trees can be destroyed by whichever of the following methods are best suited to local conditions:—

Floating the Logs.—Where water is available, the simplest method is to cut the infested logs during winter and float them as soon as cut or as early in the spring as possible; this will kill the greater part of the broods in the bark.

Sawing in Winter and Burning the Slabs.—Where it can be done profitably, the infested logs may be sawn during winter, and the slabs, which will contain the brood, burned before the spring opens.

Barking the Trees.—It is always possible to fell and bark the infested trees during winter, and when necessary, to burn the infested bark before spring opens. The presence of the greater number of the grubs in the middle layers of bark renders burning the bark necessary in the control of outbreaks involving the Western Pine Bark-beetle. Control operations should be completed usually during the period between the first of November and the following June, but the work should be finished as early in spring as possible.

When it is not possible to utilize the timber profitably, and control measures are necessary to protect valuable holdings against ravages of the beetles, the infested timber should be treated by the cheapest effective method so as to destroy the contained broods. The infested trees may be cut and burned or thoroughly charred before spring opens, frequently at less expense than by removing and burning the bark.

It will often be best to combine two or more of the available methods in order to complete the control work during late fall, winter and early spring.

This control work has reference solely to the freshly infested trees, with green, yellowish, or moderately reddened foliage, having the bark filled with the beetles and their grubs, and not to the old "red-tops" which have been dead for one and a half years or longer, and from which the beetles have emerged.

Trap-trees may be utilized in the control of some species. The importance of slash burning in bark-beetle control and the possibility of utilizing it as a trap has already been mentioned.

The Interrelations between Fire and Bark-beetles.

It has been shown that ground fires which injure and kill such large numbers of trees may provide material for the rapid development of bark-beetles. This is particularly true if the burns succeed each other year after year in neighbouring localities. This relation between fires and beetle development has probably always obtained, since fires have occurred in our forests for ages through the action of lightning and the agency of man.

When fires run through infested slashings, immense numbers of beetles may be destroyed and the fire may be very beneficial from that standpoint. When light fires run through beetle-infested timber the greater part of the broods are not affected by the heat, since only the bases of the trees are burned. If the fire is very hot so that the trees are burned far up the trunk, many of the

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PLATE 7.

BARK-BEETLE BREEDING GROUNDS (Original).

Fig. 1, Beetle-killed timber, a clump of red-top yellow pine near Princeton, B.C.
Fig. 2, Tunnels of *Dendroctonus borealis*, at base of white spruce in Jasper Park, Alta.
Fig. 3, Tunnels of *Trypodendron bivittatum* in white spruce, Jasper Park.
Fig. 4, Work of woodpeckers on a beetle infested yellow pine, Coldwater Creek Valley, B.C.

PLATE No. 7.

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broods may be killed; but the uncertain benefit to be obtained by this burning is usually more than counterbalanced by the certain injury to healthy timber and reproduction. The control of bark-beetle outbreaks in green standing timber by fire should be undertaken only with the greatest caution and under expert advice. In our opinion this method of control would usually do infinitely more harm than good.

After the beetles have killed a large part of the timber, fires are able to obtain terrific headway in the masses of dead trees, and therefore to cause an unusual amount of damage. There are at present large areas in southern British Columbia where for miles all or nearly all the pines have been killed by bark-beetles. The trees have been dead from one to ten or twelve years. When fires occur in such material as this, often on a thin and rocky soil, the heat may burn through to the rock and reduce the section to a timberless waste for generations. It is not at all improbable that the large areas of rock and range land in southern British Columbia have been produced in past ages through this joint action of beetles and fire. Whatever has happened in the past, it is practically certain that fires will eventually ruin the extensive areas now existing in that region upon which the pine has already been largely or entirely killed, as well as upon that in which the beetles are still actively operating.

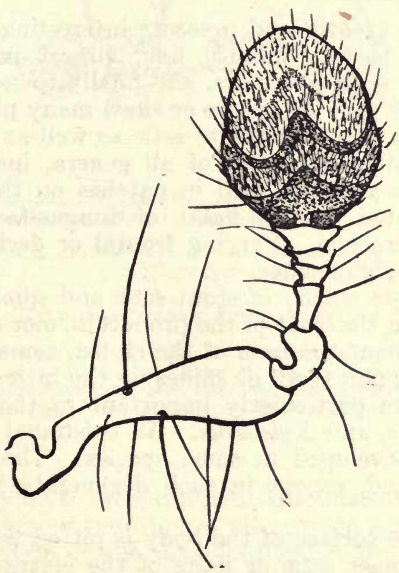


FIG 5.—IPS INTEGER EICHH., AUTENNA. Original.

III

STRUCTURAL CHARACTERS.

The structures of the ipid beetles are discussed in this paper only very briefly for the purpose of illustrating the keys for determination. The terminology already employed in literature is made use of here so far as possible.

General Characters of the Body.

The *size* varies in species of our fauna from 1 mm. in *Crypturgus* and *Pityophthorus* to 9 mm. in *Dendroctonus*. The *shape* is cylindric, varying from very stout, as in males of *Anisandrus*, to moderately elongate, *Gnathotrichus*, or elongate-oval in outline from above, as in *Leperisinus*.

The *colour* is usually dark reddish brown or black when mature; all species are yellowish when first transformed, and turn darker as the integument becomes more strongly chitinized. A few genera, as *Leperisinus* and *Pseudohylesinus*, have patches of scales of varying shades of brown and grey. Species of *Trypodendron* have the pronotum and elytra varied in black and shades of yellowish-brown.

The *vestiture* varies greatly and presents interesting characters. It varies from long slender hairs to very minute, fine, almost invisible pubescence, to very short bristles or to scale-like hairs, and finally to stout, flattened, plain or ribbed scales. The hairs may be simple or show many plumose and palmate or tuffed variations. Very stout spatulate setæ as well as spines are developed on the tibiæ. In the ambrosia beetles of all genera, including *Platypus*, very long, slender sense-hairs are developed in patches on the labial palps. These hairs are evidently related to the habit of fungus-feeding and present an interesting case of convergence. Varying frontal or declivital pubescence may be of secondary sexual significance.

The *armature* consists chiefly of stout setæ and spines on the tibiæ; lunar rugosities or asperities on the front of the pronotum, more or less strongly developed; lunar rugosities about the base of the elytra, sometimes accompanied by an elevated elytral base; and teeth or spines on the interspaces of the declivity. The declivital spines are particularly important in the classification of such genera as *Pityogenes*, *Ips*, and *Xyleborus*. An epistomal carina or process, and frontal tubercles, are developed in some species. The integument is nearly always strongly chitinized, except in such degenerate forms as the males of *Anisandrus*.

The Sculpture.—The surface of the body is pitted with setose punctures of varied structure; the longer setæ or hairs of the elytra are almost invariably borne by the interstrial punctures, and the minute pubescence from the strial punctures. The margin of the punctures is variably elevated into granules, rugosities or spines. The lunar rugosities of the pronotum and the declivital serrations are enormously developed marginal granules; they seem always connected with a setose puncture of which they are the greatly elevated front margin. The elytra are variably striate with the interspaces often convex, or carinate behind, and variably rugose. In addition to bearing punctures, granules and setæ, the head is frequently very finely aciculate, and any part of the integument may be finely reticulate.

The Head.

The *head* is somewhat quadrate and prominent, visible from above in the *Hylesininæ* and *Eccoptogasterinæ*, subglobular and more deeply embedded in

the strongly convex pronotum so as to be invisible from above in the *Ipinæ* and *Micracinæ*. It bears many of the most important characters used in classification.

The *mouthparts* are only rarely made use of in the keys given in this paper, and need not be described in detail. The labrum is absent. The mandibles are powerfully constructed, without peculiar characters. The maxillæ and labium, on the other hand, present excellent constant and peculiar characters, some of which have been used in classification by earlier writers. The objection

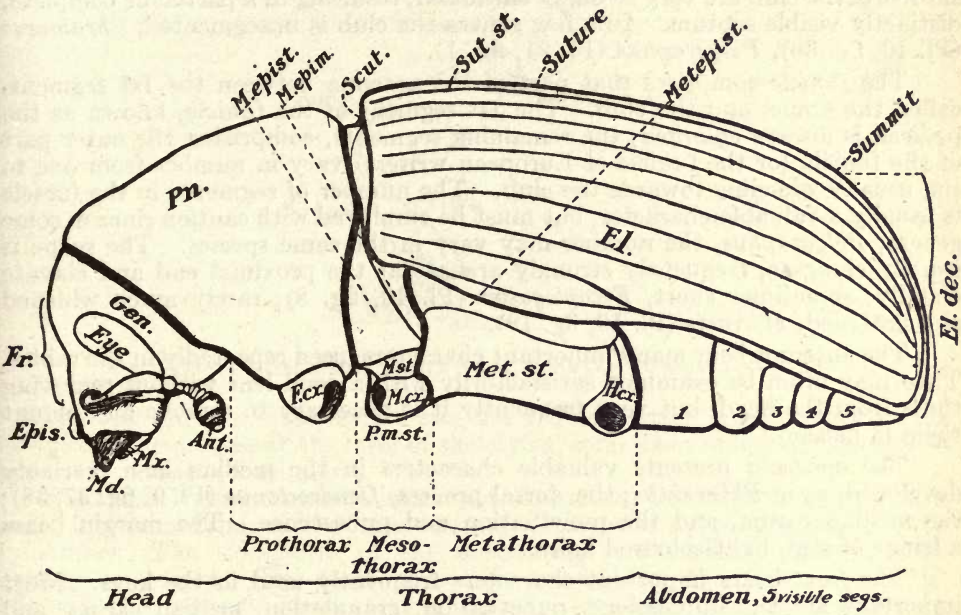


FIG. 2.—HYLURGOPS PINIFEX FITCH; SIDE VIEW. ORIGINAL.

Ant., antenna; El., elytron, showing striae; El. dec., elytral declivity; Epis., epistoma; F. cx., fore coxa; Fr. front; Gen., gena; H. cx., hind coxa; M. cx., middle coxa; Md., mandible; M. epim., mesepimeron; M. epist., mesepisternum; Met. st., metasternum; Metepist., metepisternum; Mst., mesosternum; Mx., maxilla; Pn., pronotum; P.m. st., process of the mesosternum; Scut., scutellum; Sut. st., sutural stria.

to their general use applies to most internal structures; that they can be examined only after careful dissection requiring a microscope and a certain skill in manipulation. The characters of the maxillæ include the relations of the sclerites and the structure and arrangement of the setæ. The lobe is spinose in most species, but fringed with long slender hairs in ambrosia-beetle genera. The labium is deserving of more attention than it has yet received in literature, and if it were not for the difficulty in examination, would be used freely in these keys. The mentum, ligula, and palps bear excellent generic and specific characters.

The *eyes* are feebly convex, usually elongate-oval, with the margin entire or with the front margin more or less deeply emarginate. In the genera *Trypodendron*, *Xyloterinus*, and *Polygraphus*, the eyes are completely divided by the median emargination (Pl. 9, fig. 36). *Polygraphus* is otherwise very widely separated from these other two genera, and the condition of the eyes is an excellent example of convergence.

The *antennæ* are geniculate, with a well developed scape, funicle, and a prominent club. The latter may be regularly segmented with transverse or

arcuate sutures on each side, *Pityopthorus* (Pl. 10, fig. 22), or the inner margins of the segments may be thrust towards or to the apex of the club so that the segments lie obliquely and the sutures show only at the apex or not at all upon the inner face, *Ips*; when in addition to this condition the club is thickened towards the base with the apical segments more or less completely telescoped, an obliquely truncate club is produced, as in *Xyleborus*, *Anisandrus*, *Dryocœtes*, *Pityokteines*, and *Orthotomicus* (Pl. 10, fig. 32), where almost the entire club is formed by the first segment. The distal segments are distinctly evident in *Orthotomicus*. In widely separated genera, *Pityophthorus* and *Eccoptogaster*, the sutures of the club are very strongly chitinized, resulting in a partial or complete, distinctly visible septum. In a few genera the club is unsegmented, *Chramesus* (Pl. 10, fig. 36), *Polygraphus* (Pl. 21, fig. 1).

The *funicle* comprises that part of the antenna between the 1st segment, called the scape, and the club. The 1st segment of the funicle, known as the pedicel, is always enlarged; the remaining segments, comprising the outer part of the funicle (or the funicle of European writers) vary in number from one to six, usually widening towards the club. The number of segments in the funicle is usually a valuable character, but must be employed with caution since in some genera, *Polygraphus*, the number may vary in the same species. The scape is usually elongate, frequently strongly arcuate at the proximal end and clavate distally; sometimes short, *Eccoptogaster* (Pl. 10, fig. 8); rarely much widened and flattened, *Micracis* (Pl. 10, fig. 19).

The antennæ bear many important characters, used repeatedly in the tables. They may often be examined satisfactorily with a good lens without removing them from the head, but very frequently it is necessary to remove and mount them in balsam.[1]

The *epistoma* presents valuable characters in the median lobe, variably developed, as in *Phlœosinus*; the dorsal process, *Dendroctonus* (Pl. 9, fig. 37, 38); the median carina, and the punctuation and pubescence. The margin bears a fringe of stiff, light-coloured hairs.

The *front* bears important characters frequently used in the keys. Most important are the impressions, punctuation, granulation, median carina, and pubescence. Very often the sexes show marked difference in frontal characters.

THE THORAX.

The *pronotum* is somewhat depressed in the *Hylesininæ* and *Eccoptogasterinæ*; usually strongly arcuate or gibbose in the *Ipinæ* and *Micracinæ*, although in a few genera, *Dryocœtes* and *Xylocleptes*, the convexity is less pronounced. The characters present in our genera concern the shape, punctuation, asperities of the frontal portion, granulation, pubescence, sub-basal line or margination, and the condition of the lateral margin.

On the ventral surface of the prothorax the length and concavity of the prosternum with the prosternal ridges are important, and also sometimes the punctuation of the lateral areas.

---

[1]Pin the mounted beetle securely to a cork angle. With a needle, kept moist with clearing mixture until the antenna is secured, work the antenna loose under a dissecting microscope, or a strong lens held in the left hand. Transfer the free antenna on the moist needle point to a drop of 98 per cent alcohol on a clean slide. When the alcohol is nearly evaporated add a drop of carbol-xylene, (xylol, one-half, melted carbolic acid crystals, one-half). When this is nearly evaporated add xylol-balsam and cover.

The angle used by the writer for this purpose is made of sheet cork; it has a base 4½ inches long by 3 inches wide, covered above with soft white paper, with a vertical back 1½ inches high, and a rim of Bristol board one-quarter of an inch high pinned securely about the sides and front.

Exceedingly fine needles are necessary for removing very small antennæ, and for all fine dissection under high power. The best needles known to us are those used by dentists for extracting nerves. These may be obtained either plain or with serrated edges, together with suitable handles from any dentist, or dealer in dentist supplies. The plain needles may be bent into any desired curve by drawing the point between the thumb and fore finger. They are exceedingly durable.

The Legs.—The tibiæ and tarsi present interesting modifications of great value in interpreting relationships. The third tarsal segment may be nearly normal or greatly widened and bilobed; the fourth segment may be distinct, or almost invisibly hidden in the bilobed third segment. The presence of elongate tarsal and tibial hairs is a secondary sexual character in some genera. The shape of the fore tibiæ and the condition of their spines and serrations are of great importance in the relationships of the larger groups; the individual variations in the tibial serrations, however, are frequently very great.

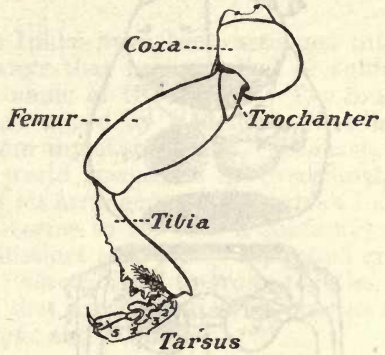


FIG. 3.—HYLURGOPS PINIFEX FITCH; FORE LEG. ORIGINAL.

The *scutellum* in these insects has the visible portion small, usually with the apex of the process at the level of the elytra, sometimes oblique or depressed and nearly invisible from above.

The thoracic sterna present important characters, but have been very little used. The condition of the mesosternum is important, particularly in the *Hylesininæ*. The side-pieces of the metathorax are variably exposed, and variably pubescent. The metepimeron is covered by the elytra or partly exposed; the metepisternum almost entirely exposed or nearly completely covered in a few genera.

THE ELYTRA.

The *elytra* are variably striate, punctured, granulate, and pubescent, with serrations in certain genera at the base or on the interspaces of the declivity. These characters are of the utmost importance in generic and specific arrangement. The strial punctures usually bear very minute setæ, while the longer hairs are almost invariably from the interstrial punctures. The elytral pubescence presents every gradation between slender elongate hairs and very short stout scales; the punctures of the striæ and interspaces vary greatly in diameter, shape and depth; the interspaces may be flat or variably convex with granulations or rugosities. The "*suture*," the junction of the two elytra along the dorsum, is frequently more or less elevated, particularly behind, by the convexity of the first interspaces, and the first or sutural striæ are frequently more deeply impressed than the others. The declivity is usually steep, sometimes truncate or concave, or almost absent with the elytra approaching the horizontal behind in a few genera, *Eccoptogaster* and *Leperisinus*, (Pl. 17, fig. 10).

THE ABDOMEN.

The apical tergites and sternites are of some importance, but will not be discussed here. The eighth tergites may be covered or exposed in one or both sexes. The five visible sternites vary considerably in the degree of fusion, relative length, and convexity; rarely they bear teeth or serrations, which may

be smaller or absent in the female. The last sternite is variably impressed and carinate behind. It is considered by some that the first two sternites are fused and hidden in the metacoxal cavities; in this paper the five visible abdominal sternites are numbered from one to five.

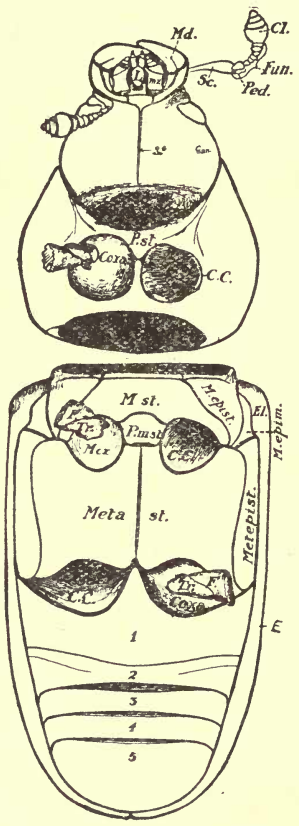


FIG. 4.—HYLURGOPS PINIFEX FITCH; VENTRAL VIEW. ORIGINAL.

C.C., coxal cavity; Cl., club; E, El., elytron; F., femur; Fun., funicle; Gen., gena; g.s., gular suture; L., labium; Md., mandible; M. cx., mesocoxa; M. epist., mesepisternum; M. epim., mesepimeron; Meta. st., metasternum; Metepist., metepisternum; M. st., mesosternum.; mx., maxilla; Ped., pedicel; Pst., prosternum; P. m. st., process of the mesosternum; Sc., scape; Tr., trochanter.

INTERNAL CHARACTERS.

Considerable attention has been devoted to the application of internal characters to taxonomy. The characters of the male and female genitalia, and the alimentary canal, particularly the proventriculus, have been discussed in papers by Lindeman, Verhœff, Sedlaczek, Nusslin, Fuchs, Hopkins, and others; and these characters have been employed in arranging keys for determination of genera and even of species. I have found these characters, especially the proventriculus, of the greatest interest and much practical value; but a wider study is apparently necessary, employing many genera and species, and particularly many specimens in each species, before definite conclusions can be drawn.

The chief drawback to the employment of these internal characters, and likewise of the mouth parts and hind wings, lies in the difficulty of their examination. While it is easy enough to make excellent mounts of the mouth parts, proventriculus and genitalia of *Crypturgus atomus*, if one has the proper equipment, it is quite impossible for the average student or forester, and a detailed discussion of these characters is therefore omitted from this paper.

IV.

CLASSIFICATION—A PRELIMINARY ARRANGEMENT OF THE CANADIAN BARK-BEETLES.

Introductory.

The genera of the Ipidæ have been arranged into tribes and subfamilies in so many different ways that now a tribal or subfamily name is indefinite unless followed by the name of the author. The four latest arrangements of the groups have been advanced by Hagedorn, Nusslin, Reitter, and Hopkins. Each differs radically from any of the others. The last, by Hopkins, representing an extensive study of world species, is an exceedingly valuable contribution; but there are sections of his arrangement with which I am as yet unable to agree. His family "*Scolytidæ*" seems to me only a subfamily; his subfamily "*Cryphalinæ*" to comprise two distinct and widely separated groups of genera; both the "*Corthylinæ*" and the "*Phlœotribinæ*" to group together genera that seem impossible in subfamilies of that extent, and *Dendroctonus* seems to me very widely separated from *Crypturgus* and *Dolurgus*.

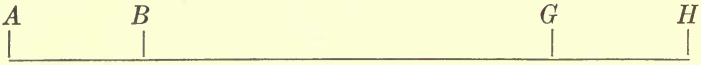
A final acceptable arrangement of the Ipidæ can be made, I believe, only after a more complete study of the external and internal characters of world species, an exhaustive study of the larvæ, and a close comparison of habits. It is of the greatest importance to study many individuals of each species, particularly in groups such as *Trypodendron* and *Dryocœtes*, in which the species are notably variable. A study of scores or preferably of hundreds of individuals of each variable species, representing different localities, forms a basis for definite conclusions; the examination of a few specimens rarely even suggests the limits of variation. Tribal and even subfamily names are usually of minor importance, often a matter of personal preference, and very largely a nuisance. The relationships of the genera are usually indicated clearly enough by the grouping in the generic keys. The keys which follow are preliminary and far from perfect; they attempt a workable arrangement of the genera and Canadian species for the use of students and foresters. Many of the doubtful points will be settled eventually only by biologic studies. Internal characters have been included in the keys but rarely, although they have been utilized extensively as checks. Keys based upon the internal characters of such small insects are obviously quite useless to the average worker, and in so far as this family is concerned these internal characters seem usually to be no more reliable for phylogenetic studies than those of the exterior.

In the present paper the four leading groups of the Canadian *Ipidæ* are recognized as subfamilies; the *Eccoptogasterinæ*, the *Hylesininæ*, the *Micracinæ*, and the *Ipinæ*.

The keys to the species include the species known to occur in Canada and those of the northern part of the United States in so far as they are represented in literature and in our collection. In a few genera, such as *Ips* and *Pityophthorus*, most of the North American species are included; but, in general, no attempt has been made to cover those genera peculiar to the southern and southwestern States. For instance, *Hypothenemus* and *Stephanoderes*, including many southern species, are not represented in Canada and are therefore disregarded. The Canadian species and others of special interest are treated briefly in the catalogue.

Paired Species.

We have to consider the status of the so-called "paired species," that is to say, species from neighbouring or widely separated areas, with the same habits and so closely similar in structure that a large section of the individuals are indistinguishable, while other individuals at the opposite ends of the series are easily separated by morphologic characters. We have, for example, a series of a species found in the spruce forests of northern British Columbia whose variations in certain characters intergrade from *A* to *G*, and a second series from Engelmann's spruce of the Rocky Mountain Region of southern British Columbia and Alberta with the same habits and the same characters as the first series, but with the variations in the characters already chosen varying from *B* to *H*. Individuals from either region lying between the points *B* and *G* on the curve are indistinguishable from those of the other region lying between the same points, while it is more or less easy to distinguish those about *A* from those about *H*.



There are apparently two explanations for such a condition. We may have to deal with two distinct species which have arisen from distinct parent forms and which through convergence have now come to intergrade; or we may have to do with a single species, all descendants of a common parent species which have varied in different directions while intergrading in the same characters throughout the great bulk of the individuals. Either of these two hypotheses may be correct, but as the second appears to be far the simpler and at the same time "practical," it should be preferred.

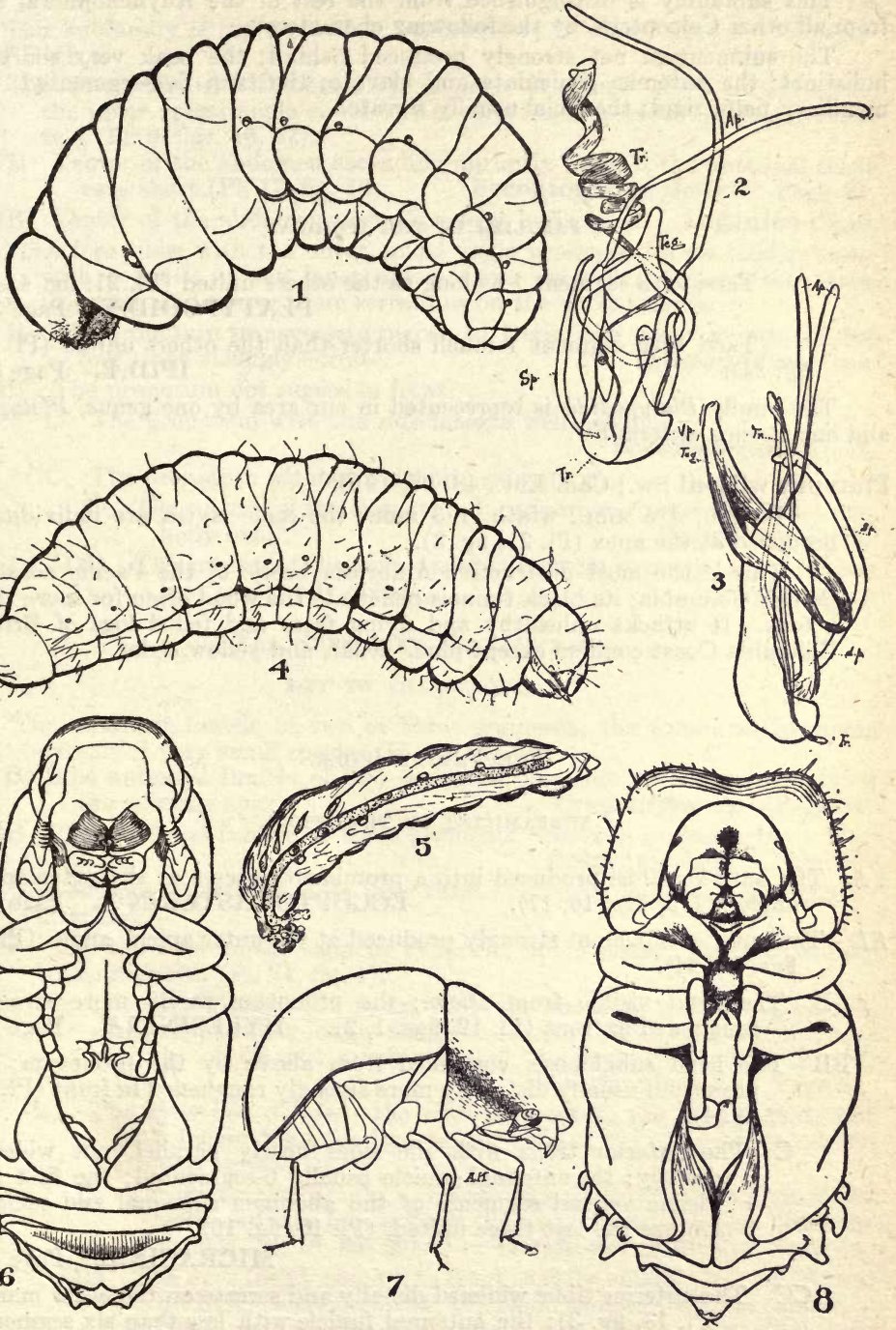
Classification has two objects; to express biologic facts, and to assist in our study of the organisms themselves. It is more important to express the facts, if we can be reasonably sure of them; but if the truth is very doubtful, as it certainly is in the case of these "paired" or "overlapping" species, it appears to the writer that the simpler and more *useful* explanation should be chosen. If the individuals about *A* and *H* were the only ones known, we should describe two species; and it is proper to do so, if good judgment is used and the description sufficient, for it is only by the publication of such studies that rapid progress can be made. If intergrading forms are discovered later, and a few names reduced to synonymy, we still have a valuable record of variations, and synonyms are surely less troublesome than composite species. But when we find many intergrading individuals in each series so that the two series overlap and much of the material cannot be determined without the place labels, the writer can see no sufficient reason in retaining two names. In this paper several series in which no constant and distinguishing characters appear are left under their several names awaiting the completion of breeding experiments.

PLATE 8.

IPID STRUCTURES—All Much Enlarged; Original.

Fig. 1, *Trypodendron retusus* Lec.; larva.
Fig. 2, *Pityogenes knechteli* Sw.; male genitalia. (See Fig. 3.)
Fig. 3, *Orthotomicus caelatus* Eichh.; male genitalia; Ap., apodemes; cc., central cavity; d.p., dorsal plate; Sp., spicule; Teg., tegmen; Tr., trough; Vp., ventral plate.
Fig. 4, *Anisandrus populi* Sw.; larva.
Fig. 5, Egg-tunnels of *Conophthorus coniperda* Sz. in white pine cone.
Fig. 6, *Eccoptogaster piceæ* Sw.; pupa.
Fig. 7, *Anisandrus pyri* Peck; male, side view (A. E. Kellett).
Fig. 8, *Trypodendron retusus* Lec.; pupa.

PLATE 8.



The Superfamily Ipoidea (Scolytoidea).

This subfamily is distinguished from the rest of the Rhynchophora, and from all other Coleoptera, by the following characters:—

The submentum not strongly produced behind; the beak very short or indistinct; the antennæ geniculate and clavate; the tarsi five-segmented; the maxillary palpi rigid; the tibiæ usually serrate.

FAMILIES IN THE IPOIDEA.

Tarsi with segment 1 as long as the others united (Pl. 21, fig. 4). **PLATYPODIDÆ.** Page 38.

Tarsi with segment 1 much shorter than the others united (Pl. 9, fig. 34). **IPIDÆ.** Page 38.

The family *Platypodidæ* is represented in our area by one genus, *Platypus*, and one species, *wilsoni* Sw.

Platypus wilsoni Sw.; Can. Ent., 48: 97, 1916.

Length, 5·5 mm.; width, 1·3 mm.; the male elytra are individually produced at the apex (Pl. 21, fig. 3).

This is the most destructive Ambrosia beetle of the Pacific coast of British Columbia; its black tunnels penetrate the wood often for more than a foot. It attacks unhealthy and dying trees and felled logs of British Columbia Coast conifers except pine,[1] cedar, and yellow cedar.

The Family Ipidæ.

SUBFAMILIES OF THE IPIDÆ.

A The anterior tibiæ produced into a prominent process at the outer apical angle (Pl. 9, figs. 16, 17). **ECCOPTOGASTERINÆ.** Page 39.

AA The anterior tibiæ not strongly produced at the outer apical angle (Pl. 9, figs. 23, 24).

B The head visible from above; the pronotum rarely more strongly roughened in front (Pl. 12, figs. 1, 2). **HYLESININÆ.** Page 39.

BB The head subglobose, concealed from above by the pronotum; the pronotum usually distinctly more strongly roughened in front (Pl. 13, fig. 4).

C The anterior tibiæ with the sides nearly parallel, not widened distally; the antennal funicle usually 6-segmented; the first two visible ventral segments of the abdomen subequal and each as long as the last three united, (Pl. 10, fig. 19). **MICRACINÆ.** Page 44.

CC The anterior tibiæ widened distally and serrate on the outer margin (Pl. 13, fig. 3); the antennal funicle with less than six segments. **IPINÆ.** Page 44.

[1] One doubtful record from Western White Pine.

The Subfamily Eccoptogasterinæ.

KEY TO THE GENERA.

This subfamily is represented in our territory by the single genus *Eccoptogaster* Herbst.

A The fore tibiæ with the outer apical angle produced into a curved spine, the inner apical angle acute but not produced beyond the tarsal insertion (Pl. 9, figs. 16, 17).

B Venter of the abdomen ascending abruptly behind; the antennal scape very short (Pl. 17, fig. 10). **Eccoptogaster** Herbst. Page 50.

BB Venter of the abdomen normal, nearly horizontal. **Loganius** Chap.

AA The fore tibiæ with the outer apical angle produced into a bifid process, with a tooth at the inner apical angle extending beyond the tarsal insertion, and one or more serrations on the outer margin.

B The pronotum transversely rugose in front, the outer margin of the fore tibiæ strongly serrate. **Erineophilus** Hopk.

BB The pronotum not rugose in front.

C The pronotum with the side margin well defined. **Bothrosternus** Eichh.

CC The pronotum without a definite side margin.

D The sutures of the club curved; rostrum narrower than the front; body oval. **Pagiocerus** Eichh.

DD The sutures of the club straight; rostrum scarcely narrower than the front; body oblong. **Cnesinus** Lec.

The Subfamily Hylesininæ.

KEY TO THE GENERA.

A The antennal funicle of two or three segments; the foretarsal segments cylindric; very small species (Pl. 10, fig. 9).

B The antennal funicle of two segments, the club with sutures only at the extreme apex. **Crypturgus** Er. Page 54.

BB The antennal funicle of three segments, the club segmented. **Dolurgus** Eichh. Page 55.

AA The antennal funicle of more than three segments; species of moderate or large size.

B The third foretarsal segment cylindric, not widened; forecoxæ almost contiguous, (Pl. 21, fig. 1).

C The eyes divided (Pl. 9, fig. 36); the antennal club unsegmented, the scape much longer than the funicle (Pl. 10, fig. 27); the base of the elytra not much elevated and feebly crenulate (Pl. 21, fig. 1). **Polygraphus** Er. Page 55.

CC The eyes not divided; the club segmented, the scape stout, but little longer than the funicle; the base of the elytra elevated and strongly serrate.

D The eyes rather deeply, narrowly emarginate; the elytral declivity with carinate interspaces; the scape slightly longer than the funicle (Pl. 10, fig. 20). **Carphoborus** Eichh. Page 56.

DD The eyes feebly sinuate in front, hardly emarginate; the elytral declivity evenly convex; the scape shorter than the funicle.

E The anterior coxæ in contact with the head beneath, the prosternum before them obsolete; the tibiæ margined with short stout teeth. Cal. **Renocis** Csy.

EE The anterior coxæ separated from the head by a very short prosternum; the tibiæ margined with long slender teeth on the outer side. **Pseudocryphalus** Sw. Page 57.

BB The third foretarsal segment distinctly widened and emarginate or bilobed (Pl. 12, fig. 1).

C The antennal club unsegmented, the funicle attached to side of club (Pl. 10, fig. 36); beak extremely short, antennal scrobes circular, attaining the eyes; eyes entire; shape of body humpbacked (Pl. 9, fig. 28); pronotum much wider than long, strongly scabrous on the sides; elytra with declivity oblique, continuing the curve of the disc, the pubescence on the elytra of short scale-like hairs and stout bristles (Pl. 9, fig. 28a).
Chramesus Lec. Page 58.

PLATE 9.

IPID STRUCTURES; ALL MUCH ENLARGED.

Fig. 1, *Orthotomicis caelatus* Eichh., labium.*
Fig. 2, *Hylurgops pinifex* Fitch, egg.*
Fig. 3, *Dendroctonus valens* Lec., egg.*
Fig. 4, *Gnathotrichus materiarius* Fitch, labium.*
Fig. 5, *Hylurgops pinifex* Fitch, tarsus, showing wide and bilobed 3rd segment.**
Fig. 6, *Xyloterinus politus* Say, labium.*
Fig. 7, *Micracis suturalis* Lec., labium.*
Fig. 8, *Anisandrus populi* Sw., labium.*
Fig. 9, *Pityogenes hopkinsi* Sw., labium.*
Fig. 10, *Trypodendron retusus* Lec., labium.*
Fig. 11, *Anisandrus minor* Sw., maxilla.**
Fig. 12, *Ips pini Say*, maxilla.**
Fig. 13, *Ips calligraphus* Say, labium.*
Fig. 14, *Dryocoetes septentrionis* Mannh., labium.*
Fig. 15, *Pterocyclon mali* Fitch, tibia and tarsus.**
Fig. 16, *Eccoptogaster piceæ* Sw., fore tibia, lower face.**
Fig. 17, *Eccoptogaster piceæ* Sw., fore leg, tarsus retracted.**
Fig. 18, *Hylastes*, a portion of the tarsus showing emarginate 3rd segment.**
Fig. 19, *Xyloterinus politus* Say, metepisternum.*
Fig. 20, *Pityophthorus*, metepisternum.*
Fig. 21, *Trypodendron retusus* Lec., metepisternum.*
Fig. 22, *Xyloterinus politus* Say, showing divided eyes.**
Fig. 23, *Phthorophloeus piceæ* Sw., tibia and tarsus.**
Fig. 24, *Pseudopityophthorus minutissimus* Zimm., fore leg.**
Fig. 25, *Leperisinus aculeatus* Say, venter of abdomen.**
Fig. 26, *Hylurgops pinifex* Fitch, venter of abdomen.**
Fig. 27, *Xyleborus celsus* Eichh., labium.*
Fig. 28, *Chramesus icoriae* Lec., side view.**
Fig. 28a, *Chramesus icoriae* Lec.. dorsal view.**
Fig. 29, *Conophthorus coniperda* Sz., labium.*
Fig. 30, *Hylastes sp.*, dorsal view of head and pronotum.**
Fig. 31, *Hylurgops pinifex* Fitch, dorsal view of head and pronotum.**
Fig. 32, *Pterocyclon fasciatum* Lec., labium.*
Fig. 33, *Trypodendron bivittatum* Ky., hind tibia and tarsus.**
Fig. 34, *Trypodendron betulae* Sw., hind tibia and tarsus.**
Fig. 35, *Hylurgops pinifex* Fitch, side view of mesosternal process.*
Fig. 36, *Polygraphus rufipennis* Ky., side of head; male.**
Fig. 37, *Dendroctonus pseudotsugae* Hopk., epistomal process.*
Fig. 38, *Dendroctonus valens* Lec., epistomal process.*
Fig. 39, *Dryocoetes americanus* Hopk., prosternal process.**
Fig. 40, *Anisandrus minor* Sw., prosternal process.**
Fig. 41, *Ips concinnus* Mannh., labium, side view.*
Fig. 42, *Hylurgops pinifex* Fitch, labium.*
Fig. 43, *Stephanoderes dissimilis* Zimm., labium.*

*Original. **Author's illustration.

PLATE 9.

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CC The antennal club segmented; the funicle attached to the end of the club.

D The antennal club loosely segmented, the segments produced on one side, sublamellate (Pl. 10, figs. 4, 6).

Phthorophlœus Rey. Page 58.

DD The antennal club connate, the segments equal sided.

E The antennal funicle 5-segmented.

F The fore coxæ very narrowly separated, practically contiguous; the metepimeron visible in part, variably distinct; the epistomal process basal and well-developed; the antennal club flattened, thickened at the base, as wide as or usually wider than long (Pl. 12, fig. 2); the eyes entire; the pronotum frequently wider than long, punctured; the elytral base not elevated, arcuate and finely crenulate; the scutellum oblique; the foretarsal segment 3 wide and deeply bilobed; the ligula in a wide band extending over the distal end of the mentum; the proventriculus with the diagonal lines of teeth very long, the transverse lines on the disc very strongly developed (Pl. 18, fig. 10).

Dendroctonus Erich. Page 60.

FF The forecoxæ moderately or narrowly separated; the metepimeron covered by the elytra; the antennal club much longer than wide; the front without a basal epistomal process.

G The funicle with the outer segments distinctly broader; the club elongate, pubescent, compressed, with three more or less strongly oblique sutures; the eyes deeply emarginate; the forecoxæ moderately distant; the prosternum moderately short; the alternate interspaces of the declivity usually serrate, more strongly in the male; the metepisternum wide, (Pl. 10, fig. 7).

Phlœosinus Chap. Page 67.

GG The funicle with the outer segments hardly widened; the club compressed, obtuse at the tip; the forecoxæ narrowly separated; the prosternum very short in front of the coxæ; thickly clothed with coarse erect hairs. Cal. **Chætophlœus** Lec.

EE The antennal funicle 7-segmented.

F Fore coxæ rather widely separated; proventriculus with diagonal lines of discal teeth absent or very feebly developed.

G Antennal club strongly compressed; elytra gradually depressed behind without a steep declivity; venter of abdomen bent upwards behind; clothed above with scales; the disc of the proventriculus not finely granulate, (Pl. 10, fig. 15).

Leperisinus Reitter. Page 70.

GG Antennal club only moderately or slightly compressed; elytra with declivity distinct and abrupt; clothed chiefly with hairs.

H Antennal club hardly flattened, subconical, with 1st segment almost as long as 2nd and 3rd united;

the proventriculus with the diagonal teeth feebly developed; episterna scaly.

Scierus Lec. Page 73.

HH Antennal club distinctly but not strongly compressed, 1st segment much shorter than 2nd and 3rd united.

I Antennal club with first suture alone strongly chitinized, distinct; each of first and second segments longer than the third and fourth united (Pl. 10, fig. 14); the proventriculus with a short diagonal band of small costal teeth backwards from base of bristles, almost obsolete on disc which is not finely granulate; ligula widened distally and truncate at tip; the distance from the front of the eyes to base of mandibles much greater than width of eyes; antennal scrobes distinctly separated from the front of the eyes; meso- and metepisterna scaly.

Hylastinus Bedel. Page 73.

II Antennal club with first two sutures strongly chitinized and distinct, the two apical segments together longer than the second; the disc of the proventriculus finely granulate; the ligula rounded at the tip; the distance between the front of the eyes and base of the mandibles hardly greater than the width of the eyes, which are narrow and elongate, passing the base of the mandibles on the ventral side of the head.

J Segments of the club indistinctly subdivided by a constriction and a row of hairs, third and fourth segments very rapidly narrowed, segments of funicle more strongly widened distally (Pl. 10, fig. 2); meso- and metepisternum scaly; 9th elytral interspace strongly carinate; scutellum oblique.

Alniphagus, new genus. Page 73.

JJ Segments of the club not so subdivided, third and fourth segments longer, segments of funicle not much widened distally; metepisternum not scaly; scutellum not depressed, (Pl. 10, fig. 1).

Hylurgopinus, new genus. Page 74.

FF Fore coxæ narrowly separated; the disc of the proventriculus with diagonal lines of teeth usually strongly developed (Pl. 18, fig. 10).

G Elytra with bases very strongly arcuate, slightly elevated and finely evenly serrulate; 1st, 2nd, and 5th ventral segments subequal in length (Pl. 9, fig. 25); ligula wide, from a convex chitinized base, narrowed distally; antennal hairs dense, stout and plumose; the metasternum somewhat inflated, (Pl. 10, fig. 3).

Pseudohylesinus Sw. Page 74.

GG Elytral bases at most but moderately arcuate and not regularly serrulate; 1st and 5th ventral segments subequal in length and longer than the others (Pl. 9, fig. 26); the ligula slender, from a box-like, strongly chitinized basal inflation; the venter of the abdomen horizontal, (Pl. 9, fig. 42).

H 3rd tarsal segment much widened and bilobed (Pl. 9, fig. 5); mesosternum protuberant in front (Pl. 9, fig. 35); bases of elytra usually rounded (Pl. 9, fig. 31.).

Hylurgops Lec. Page 80.

HH 3rd tarsal segment but little widened and emarginate (Pl. 9, fig. 18); mesosternum not protuberant; base of elytra nearly straight.

Hylastes Er. Page 77.

The Subfamily Micracinæ.

KEY TO THE GENERA.

A The antennal club 5-segmented; abdominal segments 1 and 2 each about as long as 3 and 4 together; the pronotum with an elevated area projecting beyond the base of the thorax as a median lobe. In *Cereus giganteus*, Arizona. *C. hubbardi* Sz. **Cactopinus** Sz.

AA The antennal club 6-segmented; abdominal segments 1 and 2 each as long as 3, 4, and 5 together; the pronotum normal.

B The elytra acuminate at the apex; the antennal club distinctly annulated on both sides. **Micracis** Lec. Page 83.

BB The elytra not acuminate at the apex; the club not distinctly annulated on the inner side. **Thysanoes** Lec. Page 82.

This subfamily is apparently represented from Canada by only the three specimens of (*Cryphalus*) *rigidus* Lec. in the Leconte collection, although several species of *Micracis* occur in the northeastern United States, in twigs of various deciduous trees.

The Subfamily Ipinæ.

KEY TO THE GENERA.

A The eyes divided (Pl. 9, fig. 22); the antennal club without distinct sutures; metepisternum rather wide (Pl. 9, fig. 21).

B The antennal club with the corneous basal segment broadly arcuate in front (Pl. 10, fig. 11); the metepisternum narrowed and sinuate in front, the sides parallel behind (Pl. 9, fig. 19); the male smaller than the female, with the front convex.

Xyloterinus, new genus. Page 83.

BB The antennal club with the corneous basal segment strongly angulate in front and produced towards the middle (Pl. 10, fig. 18); the metepisternum strongly sinuate behind on the inner side (Pl. 9, fig. 21); the male with the front deeply excavated, the sexes subequal in size.

Trypodendron Stephens. Page 84.

AA The eyes not divided; the club with sutures at least at the tip.

B The antennal funicle with not more than three segments; the metepisternum covered on the posterior half, the fore tibiæ but little widened distally (Pl. 9, fig. 15).

C The funicle of only one segment; the fore tibiæ without transverse ridges or asperities on the outer face, strongly serrate distally on the outer margin; stout species; Eastern States. **Corthylus** Er.

CC The funicle of two segments, the second smaller and closely attached to the club (Pl. 10, fig. 38); the fore tibiæ with transverse ridges or asperities on the outer face, serrate on the entire outer margin; elongate species (Pl. 9, fig. 15). **Pterocyclon** Eichh. Page 86.

BB The antennal funicle with more than three segments; the fore tibiæ more or less strongly widened distally (Pl. 9, fig. 24).

C The body clothed with scales or short scale-like hairs; the pronotum armed with comparatively few, large, isolated, spine-like or tuberculate asperities; small species.

D The pronotum acutely margined on the sides; stout species with the antennal club but little longer than wide.

E The elytra deeply striate.

F The antennal funicle 4-segmented, the fourth segment narrow. Eastern United States, etc. **Hypothenemus** West.

FF The antennal funicle 5-segmented, the fifth segment wide. Eastern United States, etc. **Stephanoderes** Eichh.

EE The elytra feebly striate; the funicle 4-segmented. **Cryphalus** Er. Page 87.

DD The pronotum without an acute side margin.

E The antennal funicle 4-segmented; the eyes simple.

F The anterior margin of the pronotum rounded. **Letznerella** Reitter. Page 90.

FF The anterior margin of the pronotum produced. **Procryphalus** Hopk. Page 90.

EE The antennal funicle 5-segmented, the club much longer than wide; the elytra elongate; the pronotum with rather numerous isolated asperities, rather smaller than usual, (Pl. 10, fig. 26). **Trypophlœus** Fairm. Page 90.

CC Body clothed with hairs, often nearly glabrous; pronotum with numerous small asperities or more or less distinct granules in front (Pl. 18, fig. 17).

D The pronotum finely margined with a transverse raised line near the caudal border; the metepisternum largely covered by the elytra, visible only in front (while the elytra are in the normal tightly closed position) (Pl. 9, fig. 20).

E The mouthparts, as seen from below, rather sparsely clothed with slender hairs, the maxillary lobe pilose (Pl. 9, fig. 11); the body slender, very smooth, punctures and pubescence nearly obsolete except on the declivity; the pronotum closely but feebly asperate in front, with an acute, arcuate, transverse, short carina at the summit, which is before the middle (Pl. 18, fig. 17). **Gnathotrichus** Eichh. Page 90.

EE The mouth parts, as seen from below, densely clothed with stiff hairs, the maxillary lobe spinose; the body slender or stout, usually rather strongly punctured and pubescent; the pronotum strongly asperate in front without a transverse carina at the summit, which is usually median in position.

F Body very stout; the pronotum with the marginal granules almost obsolete; the discal asperities extending over more than the cephalic half of the sides, and the disc evenly convex, without a transverse impression behind the summit; the antennal club not septate (Pl. 10, fig. 17). **Conophthorus** Hopk. Page 92.

FF Body slender to moderately stout, the pronotum with the front margin usually distinctly asperate, the sides punctured and without granules on the caudal half, the disc transversely, broadly impressed behind the summit; the antennal club usually septate (except *ramiperda*).

G Elytra and pronotum minutely and densely punctulate and densely clothed with very fine short pubescence; the club with the first segment narrower than the others; the prosternal process elongate-acute, the male with long hairs on the front, (Pl. 10, fig. 24). **Pseudopityophthorus,** new genus. Page 93.

GG Elytra and pronotum coarsely or finely and rather sparsely punctured and pubescent; the club with the 1st segment usually subequal in width to the others; the prosternal process short and wide; the special development of hairs on the front a female character. **Pityophthorus** Eichh. Page 94.

DD The pronotum not margined behind; the metepisterna distinct for the entire length.

E The antennal funicle 5-segmented.

F The pronotum precipitous or oblique in front, asperate before the summit; usually punctured behind (except *Ambrosiodmus* and *Xylocleptes*).

G The pronotum strongly declivitous and strongly asperate in front, not granulate behind (except in *Ambrosiodmus*).

H The fore tarsi only moderately widened distally; the mouthparts as seen from below clothed with many stiff hairs, the maxillary lobe spinose (Pl. 9, fig. 12); the elytral declivity usually toothed or excavated or both (Pl. 13, fig. 5). True Bark-beetles.

I The posternum very short and oblique in front of the coxæ, with the intercoxal process short, wide, not extending far between the coxæ (Pl. 9, fig. 40); the front of the female usually deeply excavated (Pl. 15, figs. 1, 2); the antennal club flat, compressed, sutured on both sides, the first segment subcircular, occupying the basal two-thirds on inner side (Pl. 10, fig. 25); [proventriculus with "closing teeth" longer than masticatory plate; the male genitalia with the

" trough " a long, spiral, longitudinally striate band. (Pl. 8, fig. 2)].

Pityogenes Bedel. Page 104.

II The intercoxal process of the prosternum long and acute (Pl. 9, fig. 39); the front not deeply excavated in either sex; the antennal club usually without sutures on the inner side or only at the extreme tip; [the "closing teeth" of the proventriculus shorter than the masticatory plate; the "trough" of the male genitalia not a longitudinally striate band].

J The concavity of the declivity separated from the apical margin of the elytra by the strongly produced, horizontal, plate-like, acute apical margin of the declivity (Pl. 14, fig. 2); the antennal club flattened, sutured throughout on the upper face (Pl. 10, fig. 10); the " trough " of the male genitalia divided into two short rods; the ligula depressed and the mentum very slender, (Pl. 9, fig. 13). **Ips** De Geer. Page 107.

JJ The declivity with the apical margin only slightly produced, at most forming a very short acute apical ridge, the plate dividing the declivital apex from the elytral apex, when present, oblique and very short; the antennal club thickened at the base, and obliquely truncate distally on the upper face (Pl. 10, fig. 33); the ligula pine-cone-shaped, the mentum moderately elongate (Pl. 9, fig. 1).

K The front of the female not densely clothed with long yellow hair; the declivital concavity separated from the elytral apical margin by a complete margin, usually acute and distinct though not strongly produced, the antennal club usually longer than wide, thick at the base with the oblique truncate distal face steep; the 7th abdominal tergite without spiracles. (Pl. 10, fig. 33).

Orthotomicus Ferr. Page 121.

KK The front of the female densely clothed with very long yellow hair (Pl. 16, fig. 3); the declivital concavity less pronounced, with the apical declivital margin almost absent towards the middle of the apex so that the sutural sulci extend to the apical margin of the elytra (Pl. 15, figs. 5, 6); the antennal club usually wider than long, strongly depressed distally; the seventh tergite with spiracles.

Pityok teines Fuchs. Page 123

HH The fore tarsi strongly widened distally (Pl. 11, fig. 2); the mouth parts with sparse slender

hairs, the maxillary lobe pilose (Pl. 9, fig. 11); the males smaller and usually differing markedly from the females (Pl. 11, fig. 1); the prosternum very short, linear in front of the coxæ. Ambrosia-beetles.

I The pronotum not serrate on the front margin, quadrate, granulate over the entire surface; the antennal club with the distal segments showing slightly as a suture at the tip of the inner side; the scutellum distinct, not depressed; the body moderately stout; the mesepimeron narrow, the metepisternum only feebly emarginate behind (*Xyleborus tachygraphus* Zimm.). Southeastern United States. **Ambrosiodmus** Hopk.

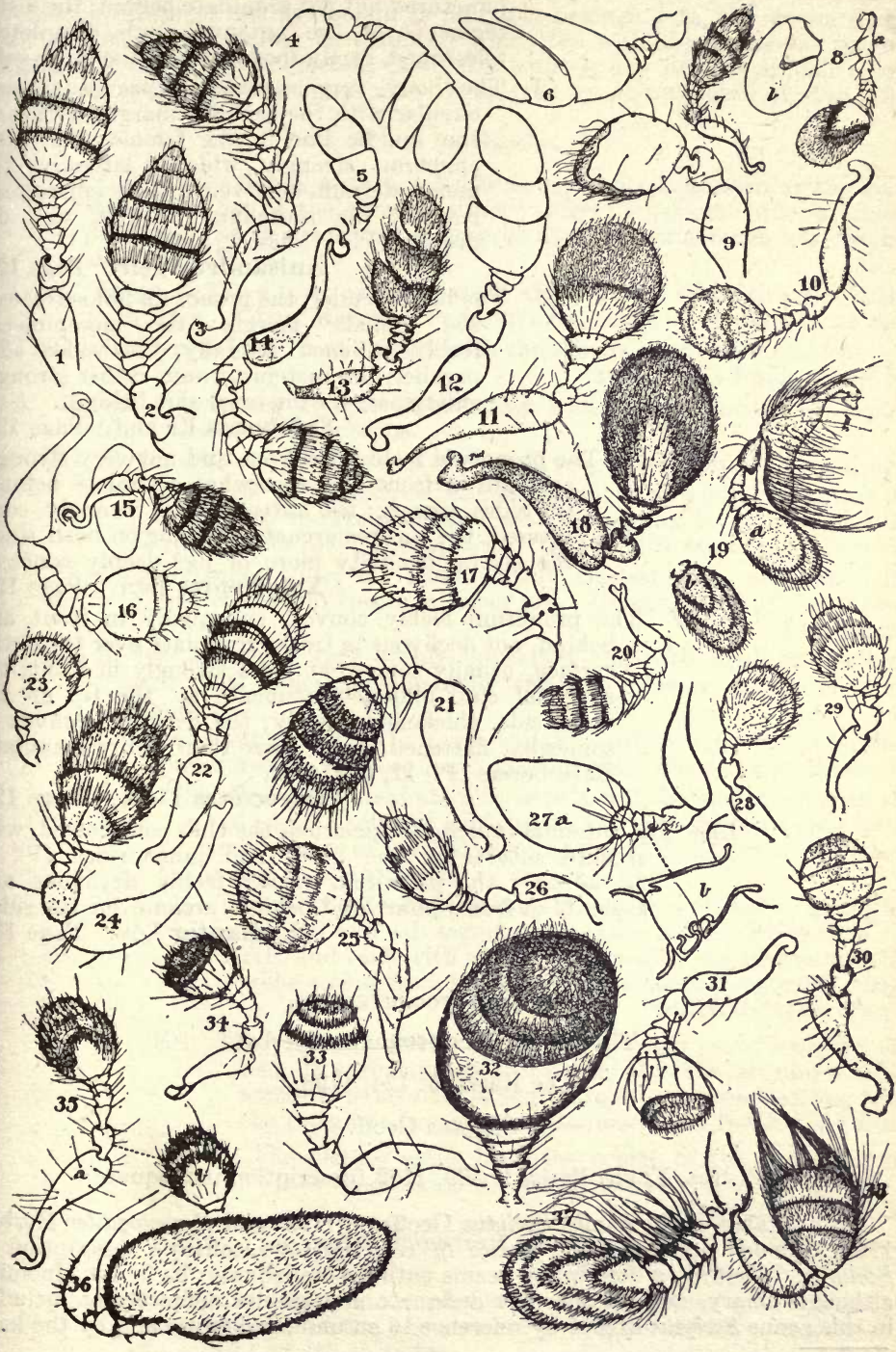
PLATE 10.

IPID ANTENNAE; All Much Enlarged.

Fig. 1, *Hylurgopinus rufipes* Eichh.*
Fig. 2, *Alniphagus aspericollis* Lec.*
Fig. 3, *Pseudohylesinus nebulosus* Lec.*
Fig. 4, *Phthorophloeus frontalis* Oliv.*
Fig. 5, *Phloeophthorus rhododactylus* Rey.*
Fig. 6, *Phthorophloeus liminaris* Fitch.**
Fig. 7, *Phloeosinus canadensis* Sw.*
Fig. 8, *Eccoptogaster piceae* Sw.**
Fig. 9, *Crypturgus atomus* Lec.*
Fig. 10, *Ips pini* Say.**
Fig. 11, *Xyloterinus politus* Say.**
Fig. 12, *Phthorophloeus spinulosus* Rey.*
Fig. 13, *Phthorophloeus piceae* Sw.**
Fig. 14, *Hylastinus obscurus* Marsh.*
Fig. 15, *Leperisinus aculeatus* Say.*
Fig. 16, *Hylurgops pinifex* Fitch.**
Fig. 17, *Conophthorus coniperda* Sz.*
Fig. 18, *Trypodendron bivittatum* Ky.**
Fig. 19, *Micracis*, undes sp.*
Fig. 20, *Carphoborus bifurcus* Eichh.*
Fig. 21, *Gnathothrichus materiarius* Fitch.*
Fig. 22, *Pityophthorus canadensis* Sw.*
Fig. 23, *Lymantor decipiens* Lec., inner face.*
Fig. 24, *Pseudopityophthorus minutissimus* Zimm.**
Fig. 25, *Pityogenes hopkinsi* Sw.*
Fig. 26, *Trypophloeus nitidus* Sw.*
Fig. 27, *Polygraphus rufipennis* Ky.*
Fig. 27B, *P. rufipennis* Ky., showing 2nd segment of funicle partly divided.*
Fig. 28, *Lymantor decipiens* Lec.; outer face.*
Fig. 29, *Cryphalus* sp.*
Fig. 30, *Dendroctonus valens* Lec.**
Fig. 31, *Dryocoetes affaber* Mannh.*
Fig. 32, *Anisandrus minor* Sw.**
Fig. 33, *Orthotomicus caelatus* Eichh.*
Fig. 34, *Dryocoetes septentrionis* Mannh.*
Fig. 35, *Ips concinnus* Mannh.*
Fig. 36, *Chramesus icoriae* Lec.*
Fig. 37, *Loganius ficus* Sz.*
Fig. 38, *Pterocyclon mali* Fitch.**

*Original. **Author's illustration.

PLATE 10.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II The pronotum asperate on the cephalic half, punctured but not granulate behind; the distal segments of the antennal club completely telescoped, rarely showing from the inner side.

J The body very stout; the pronotum subcircular with the cephalic margin serrate at the middle line in the female, the mesepimeron strongly widened laterally; the metepisternum only very faintly emarginate behind; the scutellum distinct, not dedressed (Pl. 11, figs. 1, 2).

Anisandrus Ferr. Page 124.

JJ The body slender, the pronotum not serrate on the cephalic margin; the mesepimeron feebly widened laterally, the sides subparallel; the metepisternum rather strongly emarginate on the inner side behind.

Xyleborus Eichh.* Page 126.

GG The pronotum feebly declivous and not very strongly asperate in front and somewhat granulate behind; the sides arcuate; the antennal club strongly compressed, the sutures arcuate, showing on both sides; the elytral declivity more or less deeply concave.

Xylocleptes Ferr. Page 128.

FF The pronotum feebly convex, subequally in front and behind, not declivous in front, granulate over the entire surface, usually somewhat more strongly in front; the antennal club obliquely truncate at the tip on the outer side, thickened basally; the declivity convex or somewhat flattened, never more than feebly granulate. Bark borers (Pl. 11, figs. 4, 5).

Dryocœtes Eichh. Page 128.

EE The antennal funicle 4-segmented, the club compressed, with arcuate sutures on the outer and inner sides (Pl. 9, fig. 23, 28); the pronotum rather feebly declivous and asperate in front, punctured behind, arcuate on the sides.

Lymantor Löv. Page 133.

THE ECCOPTOGASTERINÆ.

The Genus **Eccoptogaster** Herbst

Die Käfer, 5: 124, 1793.

Scolytus Geoff.

Hist. Ins. Envir. Paris, 1: 309, 1762 (description inadequate).

The status of the names *Scolytus* Geoffroy, 1762, and *Eccoptogaster* Herbst, 1793, depends upon the acceptance or rejection of Geoffroy's description of *Scolytus*. Geoffroy's description seems entirely inadequate; he is not binomial, although binary, and he does not designate any species definitely as included in this genus *Scolytus* except by reference to an unnamed figure and by the local

* Reitter, 1913, has erected the genus *Xyleborinus*, with the type *saxesceni* Ratz. This genus is separated from *Xyleborus* by the indistinct, oblique, depressed and carinate scutellum. It is included in *Xyleborus* by Hopkins as his Division I in which he has described six new species. There are no Canadian representatives known.

name " le scolite." The figure, " Planch 5, fig. 5," is poor, and although it would be identified readily enough as probably belonging to the genus *Scolytus*, it could not possibly be definitely connected with any particular species. The genus *Scolytus* was erected, therefore, without any definite specific representative, and in my opinion should be replaced by *Eccoptogaster* Herbst, 1793.

Key to the Species.

A Elytra deeply, closely striate, interstriae as deeply impressed as the main striæ; the disc of the elytra distinctly hairy; epistomal process almost obsolete. (Some specimens of *muticus* have the striæ much less distinct than normal).

B Large, 3·5 to 4 mm.; elytra sparsely clothed with long hairs over entire surface. Ohio, Missouri, Pennsylvania; *Celtis*. **muticus** Say.

BB Smaller, 2·5 to 3 mm.; elytra with short hairs over entire surface. **rugulosus** Ratz. Page 52.

AA Elytral interspaces at least moderately wide and at most only feebly striate; disc almost glabrous.

B Elytra with deep wide striæ of coarse, very closely placed punctures.

C Interspaces rather narrow; the interstrial rows finely impressed; the male with the front clothed with a fringe of long hairs, and the venter with four acute spines. **quadrispinosus** Say. Page 53.

CC Interspaces wide; the front thickly clothed with long hairs; the venter without spines in either sex. Illinois, Texas; *Celtis*, *Fagus*. **fagi** Walsh.

BB Elytral striæ not very deeply impressed and with small or medium-sized strial punctures separated usually by one or more times their diameter.

C Elytral striæ distinctly (and variably) impressed; the interstrial punctures on the disc much smaller than those of the striæ.

D The 2nd abdominal sternite with a well-developed spine in the male, and a spine or acute tooth in the female; the anterior or ventral edge of the 2nd segment rounded and feebly margined, except in *multistriatus*.

E The ventral declivity minutely and very densely punctured; the 3rd and 4th segments together much shorter than the 5th, and each with a trace of a median caudal granule; the spine arising from the *upper* part of the 2nd segment. Elm. ***multistriatus** Marsh.

EE The ventral declivity finely and sparsely punctured; the 3rd and 4th segments together subequal to the 5th, and without traces of a median caudal granule; the spine arising from the centre or from the caudal margin of the 2nd segment

F The ventral spine from the centre of the perpendicular face (2nd segment) of the declivity (Pl. 17, fig. 10). **piceæ** Sw. Page 53.

FF The ventral spine from the caudal fifth of the 2nd segment. **unispinosus** Lec. Page 53.

DD The abdomen unarmed, except rarely a faint acute carina at the apex of the 2nd sternite or a granule at the apex of the 3rd and 4th sternites.

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* Introduced into the Eastern States from Europe; not yet known from Canada.

E The wide discal interspaces finely, *confusedly* punctured near the suture; with a median granule at the apex of the 3rd and 4th sternites. Cal., N. Mexico. **californicus** Lec.

EE The discal interspaces uniseriately punctured; the 3rd and 4th sternites unarmed.

F The elytral striæ rather strongly impressed, with the punctures of medium size; the interspaces distinctly though feebly striate; the 2nd abdominal sternite opaque, very finely punctured. **tsugæ** Sw. Page 53.

FF The elytral striæ rather feebly impressed, with the punctures small; the interspaces hardly at all striate; the 2nd abdominal sternite shining, with deep punctures of medium size. **monticolæ** Sw. Page 53.

CC Elytra usually with only faint traces of striæ, the interstrial punctures usually as large or nearly as large as those of the striæ.

D The discal interspaces somewhat confusedly punctured near the suture and feebly striate, the 2nd abdominal sternite very narrow and oblique. New York. **sulcatus** Lec.

DD The discal interspaces uniseriately punctured; the 2nd abdominal sternite large.

E The ventral declivity opaque, very finely and closely punctured. Cal., Idaho, Utah, N. Mexico. **præceps** Lec.

EE The 2nd segment moderately shining and sparsely, moderately punctured. **ventralis** Lec. Page 53.

Eccoptogaster rugulosus Ratz.; Forstins. I, 187, 1837; Gossard, Ohio Agric. Exp. Sta. Bull. 264, (Biology and Control), 1905.

Length 2 mm. to 2·5 mm.; nearly black, with the antennæ, legs and tips of the wingcovers reddish brown; the pronotum with coarse, rather close, elongate punctures; the elytra rather deeply, closely striate, the punctures moderate, larger in front, close, similar on the striæ and interspaces, the interspaces striate along the row of punctures so that striæ and interstriæ are similar, interstrial punctures sometimes irregular; elytral pubescence short and sparse; the male with the front flattened rather than plano-convex as in the female; the ventral declivity strongly oblique but not excavated nor toothed.

Host trees.—Apple, Cherry, Plum, Peach, Quince, Nectarine, Black Cherry, and Wild Plum in North America.

Distribution.—In North America, Eastern United States and southern Ontario, from Texas to the Niagara peninsula. Not known from elsewhere in Canada. An injurious orchard pest.

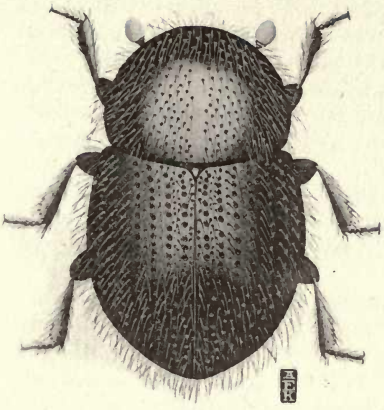
Eccoptogaster quadrispinosus Say; Acad. Nat. Sci. Phil. Jour., 3:323, 1826; ed. Lec. 2: 182, (*Scolytus*): *caryæ* Riley; Prairie Farmer, Feb., 1872; Pract. Ent. 2: 58, (*Scolytus*) 1867.

PLATE 11.

IPID BEETLES—All Greatly Enlarged. (Original.)

Fig. 1, *Anisandrus obesus* Lec., male.
Fig. 2, *Anisandrus pyri* Peck, female.
Fig. 3, *Dryocoetes affaber* Mannh.
Fig. 4, *Dryocoetes pseudotsugæ* Sw.
Fig. 5, *Dryocoetes betulæ* Hopk., female.

PLATE No. 11.



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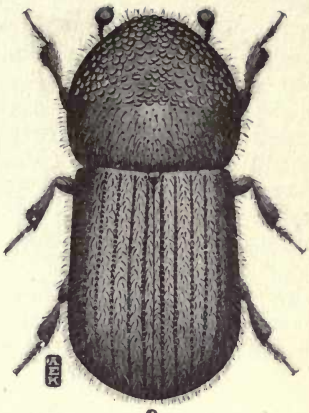

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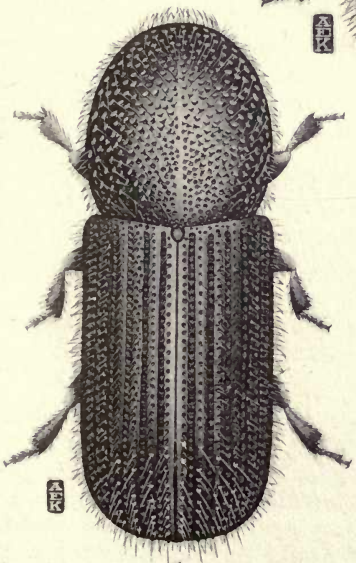

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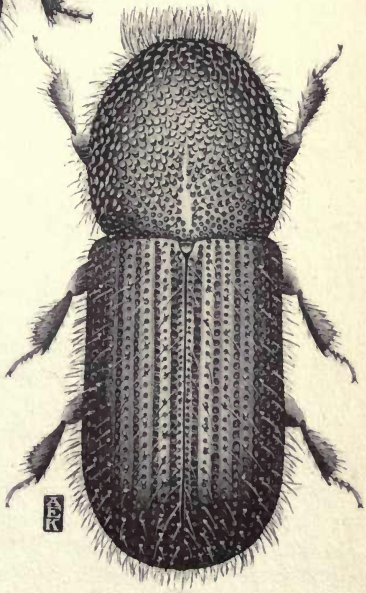

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Length, 4·2 mm. to 7 mm.; black with pubescence brown, legs, antennæ, and front margin of pronotum variably reddish. The *male* has the front broadly flattened, strongly aciculate, and fringed with long, incurved hairs; the ventral declivity deeply excavated, the cephalic margin of 2nd segment strongly produced, recurved and acute on the median line, with an acute median carina, the 3rd segment with three long caudal spines, the 4th segment with one median spine, the 5th segment very short, densely punctured and pubescent. The *female* has the front subconvex, slightly impressed in front and behind, finely aciculate, with moderate, erect, brownish hairs; the 2nd segment vertical, the 3rd and 4th segments normal, the 5th as long as the 3rd and 4th united, finely pubescent.

Host tree.—Hickory.

Distribution.—Widely distributed throughout the Eastern States as far west as Utah (our collection), but extremely rare in Canada; taken at Rigaud, Que., and Guelph, Ont., and may be said to occur in southern Quebec and southern Ontario.

A very destructive enemy of hickory.

Eccoptogaster piceæ Sw.; Can. Ent., 42: 33, 35, 1910.

Length, 2·7 mm. to 3·2 mm.; nearly black, readily identified by the characters given in the key, its host trees and its distribution (Pl. 17, fig. 10).

Host trees.—White Spruce, Balsam Fir.

Distribution.—Throughout Eastern Canada west to the Peace River Valley in northern Alberta. Breeds usually in half-dried limbs.

Eccoptogaster unispinosus Lec.; Am. Phil. Soc. Proc., 15: 371, 372, 1876 (*Scolytus*).

A small shining black species; length, 2·3mm to 3 mm.; the elytral striæ with small punctures, distinctly but narrowly impressed; the interspaces finely uniseriately punctured; the elytral punctures somewhat scabrous at the basal margin; the 2nd abdominal sternite with a spine at the caudal margin, long, flattened and blunt in the male, much shorter, conical and acute in the female.

Host trees.—Douglas Fir.

Distribution.—Generally distributed throughout the Douglas fir region of British Columbia, from Vancouver to Jasper park, Alberta.

Eccoptogaster tsugæ Sw.; Dom. Ent. Br., Dept. Agric., Bull. 14: 32, 1917.

Length, 3·4 mm.; the female front convex, aciculate-punctate and with fine hairs; the male front flat, more strongly and coarsely aciculate-punctate, the elytra hardly scabrous at the base, the 2nd abdominal sternite more coarsely margined.

Host trees.—Mountain Hemlock, Douglas Fir.

Distribution.—Cherry Creek valley, British Columbia; Glacier, B.C.; Jasper park, Alberta. Found in dying bark.

Eccoptogaster monticolæ Sw.; Dom. Ent. Br., Dept. Agric., Bull. 14: 32, 1917·

Length, 2·8 mm.; with the secondary sexual characters of *tsugæ*.

Host trees.—Western White Pine, Douglas Fir.

Distribution.—Arrowhead, B.C. (white pine); Creighton valley, B.C. (Douglas fir).

Eccoptogaster ventralis Lec.; Am. Ent. Soc. Trans. 2: 167,1868 (*Scolytus*).

Length 3.75 mm.; the type of *ventralis* Lec. is a male, apparently identical with a common form in British Columbia. The front is flattened, coarsely aciculate, punctured and conspicuously hairy; the elytral punctures rather small, somewhat coarser but only slightly rugose at the base; much less coarsely sculptured than in the female; the 2nd ventral segment strongly margined in front and with a decided median tooth-like carina at the caudal margin.

The female form which we have referred to this species has the front convex, finely punctulate-aciculate and very sparsely hairy, the elytra usually rather coarsely and rugosely punctured at the base and much more coarsely punctured throughout than the type; the 2nd segment of the abdomen occasionally with a minute median caudal granule.

E. subscaber Lec.; Am. Phil. Soc. Proc. 15: 371, 373, 1876. The type of *subscaber* is a male, with flattened, aciculate and hairy front, and shining, sparsely punctured pronotum. The elytra are scabrous at the base as in our female form, but very finely punctured behind, the interstrial punctures but little smaller than those of the striae; the striae hardly impressed but marked by a fine impressed line. The 2nd segment without a granule, and rather feebly acute in front; the 5th segment with a feeble median longitudinal carina. It was described from Vancouver but we have never taken a similar specimen in British Columbia. The other two types in Leconte's series are females identical with those just referred to as probably the female of *ventralis*.

It is possible that the type of *subscaber* Lec. is an abnormal individual of *ventralis* Lec., or it may be a distinct species. Although described from Vancouver it is not duplicated in our large collection.

Host tree.—Grand fir.

Distribution.—Vancouver island and the coast of British Columbia.

THE HYLESININÆ.

The Genus **Crypturgus** Erichson.

Wieg. Archiv., 1: 60, 1836.

Key to the Species.

A The sutural striæ suddenly and strongly impressed on the basal fourth; the surface brightly shining, the pronotal punctures moderately large and deep; the interspaces nearly as wide as the striæ, shining, smooth and sparsely punctured on the disc; the pronotum strongly rounded on the sides, suboval. **atomus** Lec. Page 54.

AA The sutural striæ feebly impressed throughout; the surface feebly shining, the pronotal punctures very small and numerous; the interspaces narrower than the striæ and strongly granulate; the pronotal sides nearly parallel on the caudal half, much more strongly narrowed in front than behind the middle.

B The pronotal punctures very feebly impressed; the elytral punctures very coarse and the interspaces extremely narrow. Pennsylvania. **corrugatus** Sw.

BB The pronotal punctures rather strongly impressed; the elytral punctures moderately coarse, and the interspaces decidedly narrower than the striæ. The Great Lakes to the British Columbia coast. **borealis** Sw. Page 54.

Crypturgus atomus Lec.; Am. Ent. Soc. Trans. 2: 152, 1868.

Length, about 1 mm.; moderately slender, brown to nearly black, shining; pronotum rounded on the sides, rather sparsely punctured; the elytra moderately punctate-striate, the sutural striæ strongly impressed on the basal third; the interspaces convex, smooth, uniseriately punctured, sparsely on the disc; the male with the postepistomal area of the front plano-concave, coarsely setose-punctate, the female with that area plano-convex.

Host trees.—Pines, Spruces, Balsam, and Larch.

Distribution.—Eastern Canada from Nova Scotia to the Great Lakes, and Eastern United States. This species, like *borealis*, usually starts its tunnels from the side of those of *Dendroctonus, Ips, Polygraphus,* or *Dryocœtes.*

Crypturgus borealis Sw.; Dom. Ent. Br., Dept. Agric., Bull. 14: 7, 1917.

Length, 1·2 mm.; closely related to *corrugatus* from Pennsylvania, but with the elytra less coarsely punctured, and slightly but usually distinctly larger. The female front with the postepistomal region triangularly flattened, coarsely reticulate and setose-punctate, the elytral tip subcircularly spongy; the male with the postepistomal area more strongly flattened, slightly plano-concave, the elytral tip normal, granulate and setose-punctate.

Host trees.—Tamarack (Manitoba), White Spruce (northern Alberta), Sitka Spruce (British Columbia Coast region).

Distribution.—Manitoba, northern Alberta, Colorado. A common species in Sitka spruce of the British Columbia Coast region presents minor differences, but is probably not distinct.

The Genus **Dolurgus** Eichhoff.

Berl. Ent. Zeitschr., 147, 1868.

Dolurgus pumilus Mannh.; Bull. Mosc., 297, 1843.

Length, 1·6 to 2 mm. Its tunnels usually originate from those of *Ips concinnus.*

Host trees.—Sitka Spruce.

Distribution.—Alaska through the British Columbia Coast region and south to Oregon.

The Genus **Polygraphus** Erichson.

Wieg. Archiv., 1:57, 1836.

In 1911 Seitner separated the genus *Pseudopolygraphus* from *Polygraphus* on the basis of the 6-segmented funicle, with *grandiclava* Thoms. as type. In 1915 Hopkins employed *Lepisoma* Kirby for the American species, *rufipennis* Ky., and the European species *grandiclava*, as distinct from *Polygraphus* Er. on account of the same character, the 6-segmented funicle. *Lepisoma* Kirby would of course have preference over *Pseudopolygraphus* Seit.

The number of segments in the funicle is usually a very important character in this family; but within the limits of the old genus *Polygraphus* Er. the variation in the number of funicular segments within the certain limits of individual species is so great that it would appear to be of doubtful value as a generic character. It has been pointed out by Rohrl that less than fifty per cent of *grandiclava* specimens examined had the funicle regularly 6-segmented. Our species, *rufipennis* Ky., appears to be more regular in this regard, having usually a 6-segmented funicle, but about one out of six in our material studied, have the funicle either 5-segmented or 5-segmented with the second segment partly divided (Pl. 10, figs. 27a, 27b). The other character given for *Pseudopolygraphus* by European writers, the lack of hairs on the second and third segments of the funicle, seems hardly of generic importance.

In view of the very close similarity in characters between the species concerned, and the intergrading variations in the generic characters proposed for *Lepisoma*, it seems desirable to include all the species under *Polygraphus* Er.

We have apparently but one species in our territory, *P. rufipennis* Ky.

Polygraphus rufipennis Ky., Faun. Bor. Am., 4: 193, *Apate* (*Lepisoma*) 1837; Bethune, Can. Ent., 4:152, 1872: *nigriceps* Ky.,; 1. c. 4: 194, 1837: *saginatus* Mannh., Bull Mosc., 237, 1853.

Length, 2-3 mm.; a stout species, black with the elytra piceous. The divided eyes and unsegmented antennal club are quite distinctive. The *female* has the front flat, shining, finely and closely punctured, and rather densely clothed with short yellow hairs; the *male* has the front convex above, with one, or more commonly two, small approximate tubercles

arranged transversely on the middle line, impressed in front of the tubercles (Pl. 21, fig. 1).

Host trees.—Spruces, Larch, and rarely in Pine.

Distribution.—Abundant throughout the spruce forests of Canada and the northern United States from the Pacific coast of Alaska east to Newfoundland.

It is found everywhere in dying spruce bark, but frequently becomes a more or less important primary enemy to black and white spruce.

Kirby's type of *rufipennis* was compared with our material by my assistant, Mr. R. N. Chrystal, and found to be the same. Kirby's *nigriceps* appeared to differ only in having the head black with the pronotum and elytra light red. Mr. Chrystal examined Kirby's type of *brevicornis*, but found it unrecognisable; only one elytron was present and the abdomen was badly shattered. The following notes were made from it: "Stout, cylindric, clothed with scales, black with the elytra very dark piceous, the front flat, without tubercles, the elytral striæ almost invisible, the surface rougher than *rufipennis*, more coarsely punctured; a female; the antennal club thicker and more knob-like than in *rufipennis*." Probably this name should be disregarded.

The Genus **Carphoborus** Eichhoff.

Berl. Ent. Zeitschr., 8:27, 1864.

An undescribed species of this genus was collected by the Canadian Arctic Expedition on the Coppermine River. It will be described in the Report of the Expedition.

Key to the Species.

A The declivital interspaces 1 and 3 moderately or feebly, subequally elevated; the male with front concave, fringed with long yellow hairs.

B The declivital interspaces 1 and 3 feebly elevated and very feebly serrate in the female, distinctly so in the male; the antennal club nearly as wide as long, with the sutures strongly arcuate; pronotum black, shining, and the elytral interspaces feebly granulate, with the scales very *minute, indistinct.* California in *Pinus ponderosa* and *P. lambertiana.* **simplex** Lec.

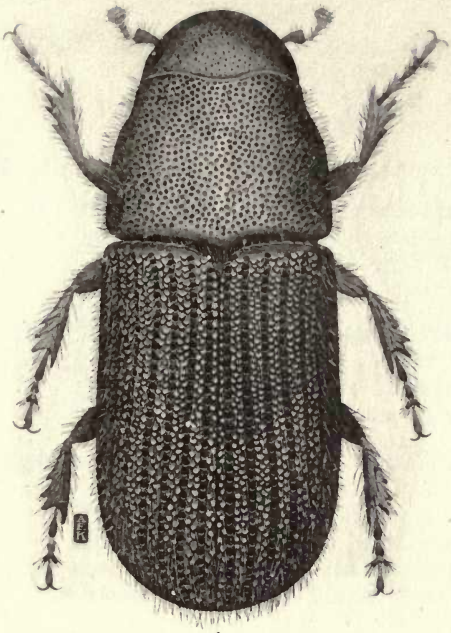
BB The declivital interspaces 1 and 3 moderately elevated and distinctly serrate; the antennal club longer than wide, with the sutures nearly straight; the pronotum more elongate, less than twice as wide as long.

C The declivity moderately and subacutely serrate on the carinate interspaces; the elytra reddish, the interspaces roughened, convex, indistinctly clothed with very small yellowish scales not concealing the surface; the female front with a blunt median tubercle surmounting the convexity. Californa. **radiatæ,** n. sp. Page 57.

PLATE 12.

IPID BEETLES—All Greatly Enlarged. (Original.)

Fig. 1, *Dendroctonus valens* Lec., The Red Turpentine Bark-beetle.
Fig. 2, *Dendroctonus pseudostsugæ* Hopk., The Douglas Fir Bark-beetle
Fig. 3, *Dendroctonus brevicomis* Lec., Details of the elytra.
Fig. 4, *Dendroctonus obesus* Lec, Details of the elytra.
Fig. 5, *Dendroctonus brevicomis* Lec., The Western Pine Bark-beetle.
Fig. 6, *Dendroctonus obesus* Lec., The Sitka Spruce Bark-beetle.



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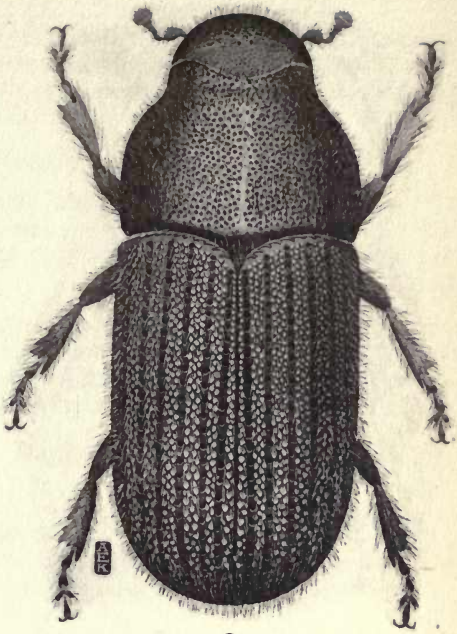

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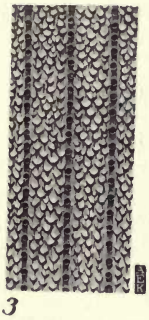

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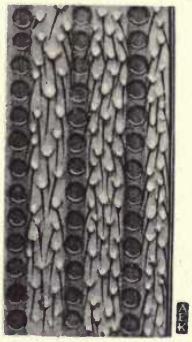

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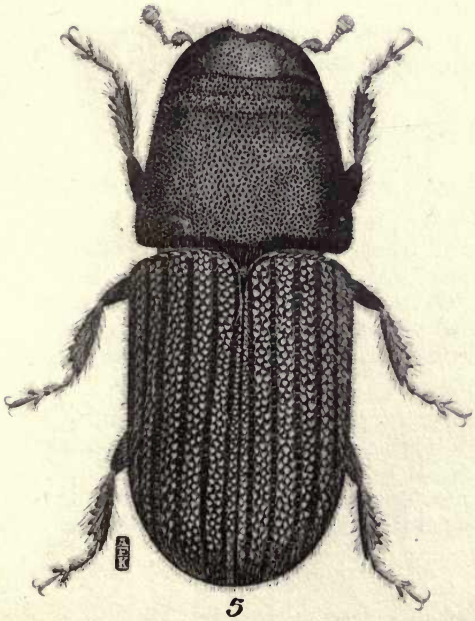

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6

CC The declivity acutely, rather feebly serrate; the elytra black, reddish on the declivity, the interspaces feebly granulate and feebly convex, densely clothed with greyish scales almost concealing the surface; the female front unarmed. **carri** Sw. Page 57.

AA Declivital interspace 3 much more strongly elevated than 1;

B The elytra lightly punctate-striate, the strial punctures minute, the interspaces wide, declivital interspace 3 very strongly carinate. The head densely clothed with long pale hairs in one sex. Middle and Southern States. **bicristatus** Chap.

BB The elytra strongly punctate-striate, the strial punctures coarse; the interspaces not wider than the striae; declivital interspace 3 strongly carinate. The front without long hairs in either sex. New York state, Tennessee, Washington, D.C. **bifurcus** Eichh.

Carphoborus carri Sw.; Dom. Ent. Br., Dept. Agric., Bull. 14: 17, 1916.

Length, 1·6 to 2mm.

Host tree.—White Spruce.

Distribution.—Banff, Alta.; Edmonton, Alta; Aweme, Man. From the eastern slopes of the Rockies across northern Alberta and Saskatchewan into Manitoba; not yet found by us farther east.

Carphoborus radiatæ, n. sp.

Length, 2·1 mm.; black with the elytra dark reddish; the pronotum feebly constricted in front, densely, finely, deeply punctured, indistinctly carinate, the pubescence minute, indistinct, yellowish; the elytra strongly punctate-striate, the strial punctures coarse, the interspaces narrower, convex, roughened, inconspicuously clothed with yellowish scales; the declivity with the alternate interspaces subequally carinate and coarsely serrate, the 3rd little more strongly and the 1st less strongly serrate. The male has the front impressed, clothed with long yellow hairs; the female has the front broadly concave in front, with a blunt median tubercle surmounting the impression. Type; in *Pinus radiata*, Carmel, California; 2940; communicated by Mr. Ralph Hopping; three paratypes; Type No. 100.

The Genus **Pseudocryphalus** Swaine.

Dom. Ent. Br., Dept. Agric., Bull. 14: 20, 1917.

Pseudocryphalus brittaini Sw.; loc. cit., Bull. 14: 20, 1917.

Length, 1·9 mm.; stout, black, with brown and gray scales; the *front* plano-concave, with a strong, transversely arcuate impression behind the epistoma, the middle line impressed, clothed with stout pubescence, becoming long, dense and pale on the epistomal margin, with a rather coarse granule behind the impression on each side the middle line; the eyes long, narrow, extending upon the ventral surface.

The *pronotum* twice as wide as long; the sides very strongly rounded behind and very strongly constricted in front; the front margin broadly emarginate at the middle; very densely subgranulately punctured, clothed with brown and grey, very stout pubescence, the grey predominating on the sides and behind; the cephalic margin unarmed or nearly so, somewhat elevated. with pale fine pubescence and brown, elongate, elevated scales;

with three pairs of elongate recurved rugosites in a longitudinal row on the middle of each side in front, the first pair on the front margin.

The *elytra* as wide as the pronotum, slightly less than one half longer than wide, the basal margin very strongly elevated, recurved and coarsely serrate in the scutellar region; the sides subparallel on the basal half, broadly rounded behind; the striæ distinctly, rather strongly impressed, the strial punctures rather coarse, not close, deep and distinct, bearing very minute setæ; the interspaces feebly convex, minutely punctured and with a median row of granules, bearing very small elongate scales which hardly cover the surface, and a median row of longer, erect, very stout bristles; the pubescence brown, with numerous scattered white scales, more abundant towards the base and forming a narrow band along the suture; the first two abdominal sternites subequal in length, each longer than the next two united.

Salmon Arm, B.C.; apple trees, in dying bark. First examined in company with Prof. W. H. Brittain.

Pseudocryphalus criddlei Sw.; loc. cit., Bull. 14: 20, 1917.

This species is very closely allied to *brittaini;* with the same size, form, and colour; but it is apparently distinct through the very feebly impressed elytral striæ, and the small, very closely placed strial punctures.

We have very few examples of *brittaini* and a longer series may show intergradations with this species.

Described from a series of 108 specimens from Aweme, Man., *Prunus virginiana;* collected by Mr. Norman Criddle.

The Genus **Chramesus** Leconte.

Am. Ent. Soc. Trans., 2: 168, 1868.

Rhopalopleurus Chap.

Syn. Scol., 46, 1869.

Chramesus icoriæ Lec., Am. Ent. Soc. Trans., 2: 168, 1868: *lecontei* Chap.; Syn. Scol. 255, 1873.

Black, length, 1·5 to 1·7 mm.; the front of the *female* flat, that of the *male* deeply concave.

This is the only Canadian species of the genus discovered thus far, and cannot be confused with any other species of our fauna. Leconte described *Chapuisii* from Louisiana, and Schæffer has described three species, *asperatus, dentatus,* and *subopacus,* from Arizona. (Pl. 9, figs. 28, 28a).

Host tree.—Hickory.

Distribution.—Eastern Canada and Eastern United States.

The Genus **Phthorophlœus** Rey.

Revue d'Ent., 2: 128, 1883.

The North American species heretofore included in *Phlœotribus* Latr. have been referred recently to *Phlœophthorus* Woll.

The species included under these three generic names form a series presenting a remarkable gradation of characters, and they will probably be included eventually under one genus. The chief characters presented by the three groups are as follows:—

Phlœotribus Latr.—Antennæ originating close together on the front; the three segments of the club produced unilaterally into very long slender lamellæ; the elytra feebly striate and not strongly granulate; the pronotum not asperate. Type, *oleæ* Fab. (*scarabœoides* Bern.).

Phthorophlœus Rey.—Antennæ originating from the sides of the front; the three segments of the club moderately produced unilaterally; the elytra coarsely striate and serrate behind; the pronotum hardly asperate. Type, *spinulosus* Rey.

Phlœophthorus Woll.—Antennæ originating on the sides of the front, the antennal club narrow, elongate, with the three segments only slightly swollen on one side; the elytra feebly striate and feebly granulate behind; the pronotum strongly asperate on the sides. Type, *perfoliatus* Woll. (*rhododactylus* Marsh).

If the three names are to be used, all our North American described species must fall in the genus *Phthorophlœus*. Such species as *frontalis* and *piceæ* are in all characters congeneric with *spinulosus* Rey, the type of *Phthorophlœus*, of which we have a long series from Russia. The species *liminaris* and *texanus* Shaeff. are intermediate as regards both external and internal characters between the *spinulosus* and *scarabœoides* types, with the antennæ arising on the sides of the front but less widely separated than in *spinulosus* and *frontalis*, the segments of the antennal club less widened than in *scarabœoides* (*Phlœotribus*) but more so than in *spinulosus*, *frontalis* and *piceæ*, the pronotum unarmed, and the elytra only feebly striate and granulate, as in *Phlœotribus*. Other characters such as the epistomal lobe and those of the proventriculus are as decidedly intermediate (see also Can. Ent., 43: 221-223, Pl. II).

Key to Northern Species.

A Club with the laterally extended segments more than twice as wide as their length at the base. Hind tibiæ rounded and toothed on the outer side; pronotum not coarsely punctured and not tuberculate; elytral interspaces nearly flat and roughly punctured (Pl. 10, fig. 6).
liminaris Harris. Page 60.

AA Club with the laterally extended segments not more than twice as wide as long (Pl. 10, fig. 13).

B Club with the laterally extended segments about twice as wide as long. Prothorax granulate-punctate, elytral interspaces elevated and serrate, more strongly behind. Atlantic States; *Celtis*, etc.
frontalis Zimm.

BB Club with the laterally extended segments about as wide as long.

C Elytral interspaces somewhat elevated; the serrations but little larger on the declivity than elsewhere; densely clothed with grey hairs not less distinct on the declivity. Colorado. **puberulus** Lec.

CC Elytral interspaces strongly elevated and serrate with granules which become large and prominent on the declivity, especially about the sides; sparsely clothed with reddish hairs, shorter on the declivity. **piceæ** Sw. Page 59.

Phthorophlœus piceæ Sw.; Can. Ent., 43: 220, 1911.

Length, 2 to 2·25 mm.; brown to black; sparsely hairy; more slender than *liminaris*. The female front with a crescentic transverse ridge preceded by a pubescent, concave, epistomal area. The male with a transverse impression on the front immediately following the transverse ridge, with the long hairs on the antennal scape but little longer than in the female.

Host tree.—White Spruce.

Distribution.—Spruce forests of western Quebec and eastern Ontario; probably more widely distributed. Breeds in moderately dry branches.

Phthorophlœus liminaris Harris; Rept. Ins. Inj. Veg., p. 78, 1852 (*Tomicus*).

Length, 2·3 mm.; rather stout; the elytra rather feebly rugose; the antennal club with the segments very strongly produced laterally; the female with the front plano-convex, the epistomal region impressed and bounded behind by an arcuate transverse carina; the male with the front more deeply concave in front of the carina and subtriangularly concave behind it.

Host trees.—Peach, Wild Cherry.

Distribution.—Eastern United States, southern Ontario, southern Quebec (Montreal region, in wild cherry).

An injurious species in peach orchards.

The Genus **Dendroctonus** Erichson.

Erichson; Weig. Arch. f. Naturgesch, II, p. 45–65, 1836; Eichh., Europ. Borkenkäfer, 125, 1881; Reitter, Bestimmungstabelle der Bork., 47; Hopkins, The Genus Dendroctonus, U. S. Bur. Ent., Tech. Series, 17, part 1; 1909.

Generic Characters.—The body rather stout, cylindric; large for the family, from 3 to 9 mm. in length; the head broad, prominent, visible from above; the beak very short, with a well developed epistomal process; the eyes transverse, short or long oval, entire; the antennal funicle 5-segmented, with the club broad, thickened basally and flattened distally; the pronotum approximately one-half as long, and nearly or quite as wide as the elytra, punctured throughout, not closely asperate in front; the anterior coxae approximate; the tarsi with the third segment dilated and bilobed; the elytra crenulate at the base, with the striae slightly or distinctly impressed, with the strial punctures small to moderately coarse; the declivity abrupt.

Key to the Canadian Species.

A The pronotum only slightly narrowed in front, feebly constricted in the male, and as wide as the elytra; the elytra without long hairs, clothed with abundant, short, nearly erect pubescence, with a few slightly longer hairs intermixed; with a frontal tubercle on each side a distinct frontal groove in the male, less evident in the female. British Columbia, in Yellow Pine (Pl. 12, fig. 5). **brevicomis** Lec. Page 62.

AA The pronotum strongly constricted in front, and *usually* slightly but distinctly narrower than the elytra; the elytra normally always with long erect hairs extending nearly to the base (frequently abraded), without frontal tubercles and groove in either sex.

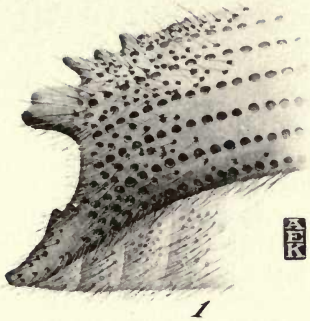
B The epistomal process narrow, with its sides nearly parallel, and extending to or beyond the anterior margin of the epistoma; the striae deeply impressed on the declivity.

PLATE 13.

IPID BEETLES—All Greatly Enlarged. (Original.)

Fig. 1, *Ips emarginatus* Lec., declivity of the male.
Fig. 2, *Ips emarginatus* Lec., declivity of the female.
Fig. 3, *Orthotomicus caelatus* Eichh.
Fig. 4, *Ips plastographus* Lec.
Fig. 5, *Ips emarginatus* Lec.

PLATE No. 13.



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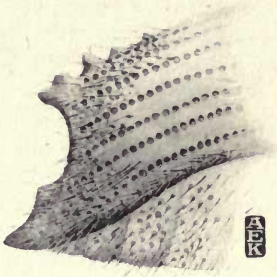

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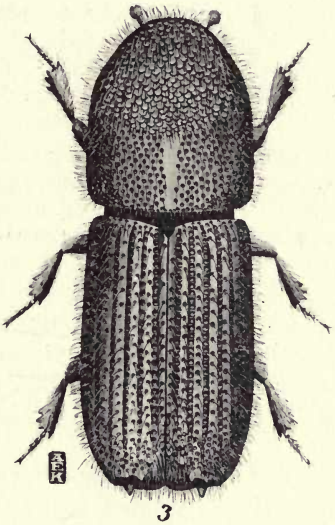

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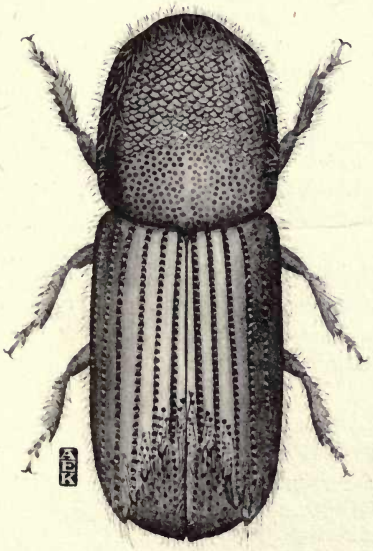

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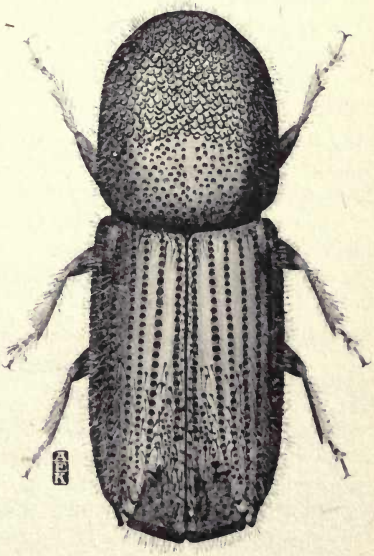

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C The pronotum finely, closely punctured, more finely, densely, and regularly on the middle of the sides behind; the epistomal process usually projecting slightly beyond the epistomal margin. British Columbia. **pseudotsugæ** Hopk. Page 62.

CC The pronotum coarsely, rather sparsely punctured; not more densely and regularly on the middle of the sides behind; the epistomal process not projecting beyond the epistomal margin. In Eastern Larch. **simplex** Lec. Page 62.

BB The epistomal process wide, with the sides strongly oblique, the cephalic margin of the process concave, with the angles more or less evidently tuberculate, shorter than the epistoma.

C The punctures of the pronotum large and shallow, disclosing the bottom, fairly regular in size, without very small punctures intermixed; the front without a median, posterior impression; large species, 5 to 9 mm.

D The pronotal punctures only moderately coarse and shallow, and closely placed; the colour usually yellowish brown to dark reddish brown, rarely very dark piceous or black; the epistomal process usually with the oblique sides long so that the process is notably wide. **valens** Lec. Page 63.

DD The pronotal punctures very large, very shallow, and rather sparse; the colour usually dark piceous or black; the epistomal process with the sides short, and the angles usually more strongly tuberculate. The Southern States, north to New Hampshire. **terebrans** Oliv. Page 64.

CC The punctures of the pronotum deep and small, more or less evidently intermixed with larger punctures; the front impressed on the median line towards the vertex.

D The caudal half of the proepisternal area distinctly punctured.

E The declivital striae coarsely punctured. **punctatus** Lec. Page 65.

EE The declivital striae finely punctured.

F The caudal half of the proepisternal area rather closely punctured and strongly roughened; the declivital interspaces strongly punctured; the basal crenulations of the elytra slightly separated, hardly overlapping. **murrayanæ** Hopk. Page 64.

FF The caudal half of the proepisternal area rather sparsely punctured and only feebly roughened; the declivital interspaces feebly punctured; the basal crenulations of the elytra close and overlapped. **rufipennis** Kirby. Page 64.

DD The caudal half of the proepisternal area granulate, with the punctures indistinct.

E The pronotum as wide as the elytra; the punctures of the pronotum small and moderately regular in size. **monticolæ** Hopk. Page 65.

EE The pronotum slightly but distinctly narrower than the elytra; the pronotal punctures decidedly irregular in size.

F The punctures of the discal striæ of the eltyra frequently small and deep; Alaska, the Yukon, British Columbia and Alberta, in White and Engelmann's Spruce. **borealis** Hopk. Page 66.

FF The punctures of the discal striæ of the elytra usually coarse.

G The average size smaller, 5·5 mm.; the elytral striæ somewhat more commonly strongly im pressed on the sides. East of the Great Lakes, in Eastern Spruce.
piceaperda Hopk. Page 66.

GG The average size larger, 6·5 mm.; the elytral striæ more commonly faintly impressed upon the sides. The northern Pacific coast in Sitka Spruce.
obesus Mannh. Page 66.

Dendroctonus brevicomis Lec.; Am. Phil. Soc. Proc., 15: 384, 386, 1876.

Length, 3·2 mm. to 5 mm., average 4·2 mm.; colour dark brown to black; the front elevated on each side of a deep median groove in the male, faintly so in the female; sides of the epistomal process oblique; the pronotum shining, *hardly constricted in front*, feebly so in the male; *the elytra as wide as the pronotum;* the striæ faintly impressed, the strial punctures very small, the discal interspaces *densely, finely* asperate, the declivital striæ faint; broadly impressed on each side of the elevated suture; *the pubescence rather abundant, everywhere short, erect, and inconspicuous,* with a few slightly longer hairs intermixed on the declivity. The female has a narrow, transverse elevation across the pronotum behind the cephalic margin, continued across the sides; the male has a transverse depression similarly situated. (Pl. 12, fig. 5).

The egg-tunnels are winding, more or less transversely, the egg-niches separated, the larval mines in the inner and middle layers of bark.

Host tree, in British Columbia.—Western Yellow Pine.

Distribution.—Throughout the range of yellow pine in British Columbia and in the Western States.

Economic importance.—This species assists *monticolæ* in extensive outbreaks in southern British Columbia.

D. barberi Hopk. (Arizona, North Mexico, Texas, Colorado, Utah), is described as distinct through coarser rugosities of the elytral interspaces and more distinctly impressed elytral striæ.

Dendroctonus pseudotsugæ Hopk.; Bur. Ent. U.S. Dept. of Agric., Tech. ser, 17, pt. 1, The Genus Dendroctonus, p. 126, 1909.

Length, 3·5 mm. to 7 mm., average nearly 6 mm.; the colour dark brown to nearly black, and black with the elytra red; the epistomal process with the sides parallel and with its anterior margin usually projecting slightly beyond the margin of the epistoma; the pronotum shining, finely, closely punctured, with few larger punctures intermixed. Very closely allied to *simplex* Lec., but entirely distinct (Pl. 12, fig. 2).

Host trees.—Douglas Fir and Western Larch in British Columbia, and in United States, Big Cone Spruce, in addition.

Distribution.—It follows the range of its host trees in British Columbia, and apparently also in the United States.

Economic importance.—This species prefers dying bark and is found everywhere in British Columbia in slashings of its host trees. Small outbreaks in living timber are found in British Columbia, but these are easily controlled by proper disposal of slash. It may become an important primary enemy.

Dendroctonus simplex Lec.; Am. Ent. Soc. Trans., 2: 173, 1868.

Length, 3·5 mm. to 5·2 mm., the average about 4·7 mm.; the front convex, densely, roughly punctured, with the median line finely impressed

in front and behind, *the epistomal process with the sides nearly parallel, its front margin reaching but not passing the epistomal margin;* the pronotum constricted in front with the punctures distinctly irregular in size, small, with a few coarse punctures intermixed, moderately close, small and more regular in size behind; the elytra slightly wider than the pronotum, the striæ moderately impressed, the strial punctures small and deep, the interstrial granulations coarse and sparse; the declivity with the striæ rather deeply impressed, the strial punctures very small and deep, the interspaces coarsely, sparsely, uniseriately asperate, and finely, very deeply punctured; the hairs are sparse, erect and moderately long, extending nearly to the base of the elytra, with the minute pubescence indistinct. The male has the elytral striæ more strongly impressed on the declivity, the declivity brightly shining, not asperate except at the sides, smooth, but deeply, rather closely punctured.

The egg-tunnels are longitudinal, somewhat winding, variably branched and anastomosing, grooving the inner bark and the wood surface; the eggs are arranged in small groups, the larval mines and pupal cells in the inner bark.

Host tree.—Eastern Larch.

Distribution.—This species is abundant in dying larch throughout the larch areas of Eastern Canada from the Atlantic westwards across Manitoba, northern Saskatchewan, and northern Alberta. A rather distinct variation occurs about Lesser Slave Lake. It probably follows the eastern larch throughout its range in North America.

Economic importance.—This species prefers dying bark, but may become a serious enemy to trees weakened by the sawfly or through other causes.

Dendroctonus valens Lec.; Pac. R. R. Explor. Ins. V, 12, pt. 2, p. 59, 1860.

Length, 5 mm. to 9 mm., usually 7 to 8; a large reddish species, sometimes piceous, or rarely black in old individuals; the epistomal process broad, concave, the sides oblique, the median line of the vertex black; the pronotum faintly narrower than the elytra, moderately constricted in front, the punctuation rather large, strongly impressed, fairly regular in size, and close, smaller and denser towards the caudal margin; the elytral striæ distinctly impressed, the discal interspaces convex, rather coarsely granulate; the striæ impressed on the declivity, with small rather indistinct punctures, the pubescence sparse and short with a few long hairs on the declivity and disc, frequently denuded (Pl. 12, fig. 7).

The *egg-tunnels* are usually at the base of living or dying trees, or stumps; they are longitudinal, variably winding and branched, and may reach more than a foot in length; cut in the inner bark somewhat grooving the wood; the eggs are placed in layers at intervals along the tunnel walls; the larvæ feed in congress, excavating chambers of varying size between the bark and the wood surface (Pl. 27, fig. 7).

Host trees.—Abundant in Western Yellow Pine and other pines and spruces of southern British Columbia, and in pines and spruces of Eastern Canada.

Distribution.—Throughout the pine and spruce forests of Eastern Canada and in southern British Columbia, and southward throughout the United States. We have no records from the northern parts of Saskatchewan, Alberta, and British Columbia, nor from the Yukon.

Economic importance.—An important assistant of *monticolæ* and *brevicomis* in outbreaks in British Columbia yellow pine. Frequently found killing patches of bark at the base of living pines and spruces.

Dendroctonus terebrans Oliv.; Ent. 4: 78, p. 6, pl. 1, fig. 6, a–b, 1795, *Scolytus;* Hopkins, The Genus Dendroctonus, 147, 1909.

Distinguished from *valens* by the very coarse, very shallow and sparser punctures of the pronotum; the colour is usually nearly black, and the epistomal process has the oblique sides much shorter with the angles usually more tuberculate.

Host trees.—Pines and Spruces.

Distribution.—It is apparently a southern form ranging north to New Hampshire; we have no records from Canada. In habits it is allied to *valens* Lec., from which it is barely distinct.

Dendroctonus murrayanæ Hopk.; U.S. Bur. Ent., The Genus Dendroctonus, 140, 1909.

Length, 5 mm. to 6·5 mm. It is very closely allied to *rufipennis* Kirby, but appears to be distinct through the characters enumerated under that species. The proepisternal area is distinctly punctured, but rather coarsely granulate and roughened; the basal crenulations of the elytra are sparser than usual, distinctly separated and hardly overlapped.

Host trees.—Lodgepole Pine. Recorded by Hopkins also from Engelmann's Spruce.

Distribution.—It has been taken in Canada only in the Rockies of southern British Columbia, but it may follow the distribution of its host. Not uncommon in stumps at Banff, Alta.

Economic importance.—It is not at present a very injurious species in our forests.

Dendroctonus rufipennis Kirby; Fauna Boreali Americana, p. 195, no. 261' 1837; Hopkins, The Genus Dendroctonus, 138, 1909.

Length, 6 mm.; black with the elytra dark red; the sides of the epistomal process oblique; the *pronotum* constricted in front, the punctures close, rather coarse, distinctly irregular in size, small and more regular behind, the caudal half of the proepisternal area distinctly punctured, with the punctures coarse, not close, shallow, not strongly granulate, so that the surface is not much roughened; the *elytra* slightly wider than the pronotum, the basal crenulations individually distinct but overlapping, the striæ rather faintly impressed, the strial punctures rather coarse and distinct, the discal interspaces narrow, with the coarse granules irregular, sparse, and acute, except at the base; the declivital striæ narrowly, decidedly impressed, with very small punctures, the declivital interspaces uniseriately finely granulate and very finely, sparsely, indistinctly punctured; the vestiture sparse, the long hairs extending to the base of the elytra; the male with the declivity more shining, the interspaces obsoletely granulate and more distinctly punctured. This species differs from *murrayanæ* Hopk., as here interpreted, in the smoother, less deeply and roughly punc-

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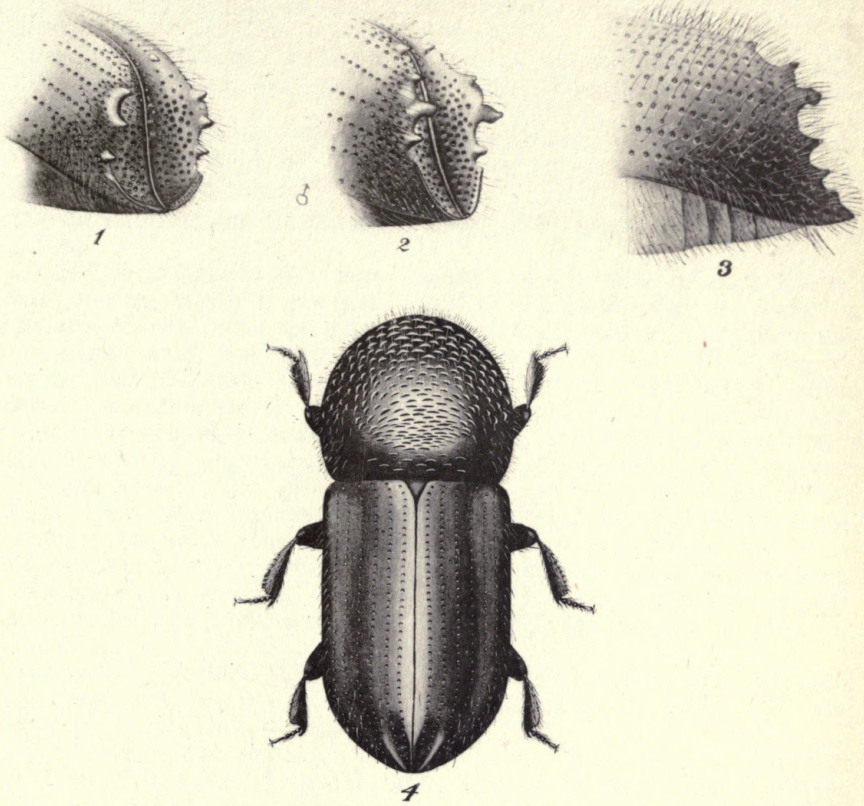
PLATE 14.

IPID BEETLES—All Greatly Enlarged. (Original.) A.E.K.

Fig. 1, *Ips pini* Say, Declivity of the female.
Fig. 2, *Ips pini* Say, Declivity of the male.
Fig. 3, *Ips grandicollis* Eichh., Declivity of the male.
Fig. 4, *Trypodendron retusus* Lec.
Fig. 5, *Ips perroti* Sw., Declivity of the female.
Fig. 6, *Ips perroti* Sw., Declivity of the male.
Fig. 7, *Ips concinnus* Mannh., Declivity of the female.
Fig. 8, *Ips concinnus* Mannh., Declivity of the male.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tured proepisternal area, the narrower and more sparsely asperate discal interspaces, the more sparsely and finely punctured declivital interspaces, and the close and overlapped basal crenulations of the elytra.

Host trees.—White Pine and Jack Pine.

Distribution.—From northern Manitoba across northern Ontario, and northern Quebec, and probably to the Atlantic. Recorded from Michigan by Hopkins.

Economic importance.—We have taken it only in trees dying from other causes. The type of our description agrees with Kirby's type; compared by R. N. Chrystal.

Dendroctonus monticolæ Hopk.; Bur. Ent., U.S. Dept. Agric., Bull. 56, p. 11, 1905.

Length, 3·7 mm. to 6·7 mm.; colour usually black or dark brown; the front convex, faintly impressed behind on the middle line; *the pronotum as wide as the elytra*, with the sides strongly constricted in front, *the punctuation close, small, not very evidently irregular in size* (Pl. 7, fig. 7); the elytra with the striæ distinctly impressed, more feebly on the sides, the strial punctures small, the interspaces slightly convex on the disc, with moderately close granules of varying size; the declivital striæ rather strongly, narrowly impressed, with very small punctures, the 2nd and 3rd strongly sinuate; the pubescence of the elytra short and sparse, with a few longer hairs extending nearly to the base, and numerous short subrecumbent hairs on the sides, (the long hairs usually more or less abraded).

The egg-tunnels are vertical, elongate, straight to moderately winding, with the egg-niches arranged not very regularly in small alternate groups; the larval mines and pupal cells mostly exposed in the inner bark, grooving both bark and wood (Pl. 30).

Host trees.—Western White Pine, Western Yellow Pine and Lodgepole Pine in British Columbia. Also recorded from *Pinus lambertiana* and *Picea engelmanni* in United States.

Distribution.—Throughout the range of its host trees in southern British Columbia west of the Rockies, and in Western United States.

Economic importance.—This is the most destructive bark-beetle of British Columbia forests; it has already destroyed an enormous amount of timber in southern British Columbia.

D. ponderosæ Hopk. has not been recognized from British Columbia. It is described as distinct from *monticolæ* through "its average larger size, somewhat stouter form, with the elytral striæ more distinctly impressed, and the punctures distinctly coarser."* It is destructive to pine forests in the central and southern Rocky Mountain region.

Dentroctonus punctatus Lec.; Trans. Am. Ent. Soc. II, 173, 1868; Hopkins, The Genus Dendroctonus, 72, 142, the only valuable description.

This species is recorded by Hopkins in *Picea rubens*, from New York to west Virginia. It is probably very rare, and has never been recorded from Canada.† The coarse punctures of the elytral striæ, especially on the declivity, separate it from its allies, as indicated in the key.

Dendroctonus engelmanni Hopk.; U.S. Bur. Ent., The Genus Dendroctonus, p. 130.

This species was described from the Rocky Mountain region of the United States, and Canadian records were given from "(Horn) "H.B." (Northwest Territory, probably Mackenzie River region)"; "(H. & S) Calgary, Alta.; Glacier, B.C." These were probably similar to our more coarsely punctured specimens left in this paper under *borealis*.

* Hopkins, the Genus Dendroctonus.

†Since this was written a species has been collected on the Coppermine River near the Arctic Ocean by Mr. Johannsen of the Canadian Arctic Expedition which is either *punctatus* Lec. or a closely allied undescribed species.

Dendroctonus borealis Hopk.; U.S. Bur. Ent., The Genus Dendroctonus, 133, 1899.

The length varies from 5 mm. to 7 mm.; long series from the Rockies and Lesser Slave Lake are as large as the average of *obesus*, while from some localities the size is usually smaller; the punctures of the elytral striæ are usually small and rather indistinct, but very many individuals have these dorsal punctures quite as coarse as in typical specimens of *obesus;* the elytral striæ are more constantly distinctly impressed, but in this character also there is great variation. Much of our material from the southern Rockies, the Selkirks and the southern interior of British Columbia agrees with the characters given for *engelmanni* Hopk., but the intergradation with the typical *borealis* is so complete that the name *borealis* is employed for all our variations discussed here from Alberta and the interior of British Columbia.

Host trees.—White Spruce, Engelmann's Spruce.

Distribution.—Alaska, the Yukon, throughout the interior of British Columbia and northern and western Alberta. We have also taken it in white spruce in northern Manitoba.

Economic importance.—An important secondary enemy and frequently a serious primary enemy to white and Engelmann's spruce throughout its range. Incipient outbreaks should not be neglected. It has killed a large amount of timber in Northern Alberta.

Dendroctonus piceaperda Hopk.; Bur. Ent., U. S. Dept. Agric. Bul. 28, N.S., p. 16.

This species is very closely allied to the *obesus-borealis* series. The head and pronotum are entirely as in *borealis* and *obesus*, with similar slight variations. The elytral striæ are usually distinctly impressed and the punctures of the discal striæ are usually rather coarse and distinct. The size is usually smaller than in *borealis* and *obesus;* a series from Newfoundland is constantly 5 mm. long; and another long series from Sydney, N.S., varies between 5·75 mm. and 6·2 mm. The writer has taken *borealis*, with small discal punctures, as far east as northern Manitoba; when long series are available from the region between Manitoba and northern Quebec, the relations between *borealis and piceaperda* can be discussed more satisfactorily. Individual specimens of *piceaperda* are best separated by the rather coarse and deep strial punctures of the disc and the deeply impressed striæ, but exactly the same conditions are commonly found in our series from the northern Rockies and Alberta.

The egg-tunnels are longitudinal, usually short, in the inner bark, grooving the wood surface; the eggs are closely placed in rather large groups, alternately, on the tunnel wall; the larval mines usually separate at a short distance from the tunnel; they are exposed in the inner bark and the pupal cells are usually exposed.

Host trees.—Red, White, and Black Spruce.

Distribution.—Michigan and central Pennsylvania (Hopkins), northwards through Maine and the Maritime Provinces to Newfoundland.

Economic importance.—This species is one of the most destructive in the genus. It has killed enormous quantities of spruce, particularly in Maine and south western New Brunswick.

Dendroctonus obesus Mannh.; Bull. Mosc., p. 296, 1843; Hopkins, U.S. Bur. Ent., The Genus Dendroctonus, p. 135, 1909.

Length, 5·5 mm. to 7 mm., the average about 6·5 mm. The colour when mature is usually deep black, rarely reddish. The punctures of the discal striæ are usually coarse and distinct; the shape is frequently slightly more elongate than is usual in *borealis*, with the hairs often denser, but

these characters are hardly reliable; the elytral striæ are usually faintly impressed, especially on the sides. *D. borealis* Hopk. usually has the elytral striæ a little more evidently impressed, with the punctures of the discal striæ smaller and less easily distinguished. The variations in *obesus* from the west coast, and in *borealis* from Alberta and the Rockies are so numerous that many individuals could never be determined if the place and host labels were removed. We have long series from the regions just named, but have made no collections in the section between Jasper Park and the Pacific Coast. When long series are available from that intervening region, the status of *borealis* may be more definitely decided. At present I am of the opinion that *obesus*, *borealis* and *engelmanni* form one variable species, with *piceaperda* only doubtfully distinct. (Pl. 12, fig. 6).

Host tree.—Sitka Spruce.

Distribution.—The Pacific Coast, from Alaska southwards into the United States throughout the range of the host tree.

Economic importance.—It evidently prefers dying bark under ordinary conditions, but readily attacks trees of the largest size, at most but slightly weakened, and is without doubt a destructive primary enemy when the right conditions obtain.

The Genus **Phlœosinus** Chapuis.

Chapuis, Syn. Scol., p. 37, 1869.

**Key to the Species.*

A The mesosternum precipitous, at least very steep, between the coxæ; the intercoxal piece of the prosternum usually wide; the antennal club with the sutures subtransverse, only moderately oblique, (excepting *punctatus*.)

B The mesosternum transversely, acutely carinate between the coxæ; the metasternum sparsely, feebly punctured; the declivital interspaces similar, feebly convex, uniseriately granulate; breeds in *Pinus banksiana*. **pini** Sw. Page 69.

BB The mesosternum not carinate; the metasternum usually coarsely and roughly punctured.

C The strial punctures very distinct and coarse on the disc, in deeply impressed striæ of moderate width; the 2nd interspace on the declivity evidently narrower than the 1st and 3rd.

D Very small species, the length, 2 mm. or less; the pubescence distinct; the discal interspaces with coarse uniseriate asperities in addition to the granules.

E The declivity reddish, minutely scaly, with 1st and 3rd interspaces strongly serrate and much more strongly elevated than the 2nd. California. **hoppingi** Sw.

EE The colour entirely black, declivital vestiture hairlike, with 1st and 3rd interspaces feebly serrate and but little more elevated than the 2nd. California. **minutus** Sw.

DD Of medium size, the length, 2·2 mm. to 3 mm.; the pubescence indistinct; the discal interspaces confusedly very coarsely granulate; the striæ wide and the punctures very coarse. **punctatus** Lec. Page 69.

* For *serratus* Lec. see page 70.

CC The strial punctures usually indistinct and always small; in very narrow, moderately impressed striae; the second interspace on the declivity nearly or quite as wide as the 1st or 3rd.

D The elytral interspaces on the disc and sides sparsely nearly uniseriately granulate; the declivital interspaces only faintly convex, with the granules uniseriate, almost obsolete. A very small, brightly polished western species; length, 2·2 mm. California. **vandykei** Sw.

DD The elytral interspaces on the disc and sides densely or rather sparsely but confusedly granulate; the declivital interspaces moderately convex with the serrations well developed.

E The elytral interspaces rather coarsely sparsely granulate and somewhat convex; the striæ distinctly impressed; the second interspace on the declivity slightly narrower than the 1st or 3rd and moderately narrowed distally, shining, smooth, feebly punctured, nearly flat, and unarmed; the serrations of the first interspace uniseriate in both sexes; the pubescence longer than usual and distinct. **canadensis** Sw. Page 69.

EE The elytral interspaces closely granulate, wide and flat; the striæ hardly impressed; the 2nd interspace on the declivity as wide as the others, closely roughly punctured and more or less serrate; the serrations of the first interspace confused in the female; the pubescence very short and not conspicuous.

F The pronotum densely finely punctured; the elytral interspaces densely, rather finely granulate, the pubescence of the declivity minutely hairlike in both sexes, hardly scale-like; a small species, less than 3 mm. in length. **dentatus** Lec. Page 70.

FF The pronotum closely finely punctured; the elytral interspaces rather coarsely granulate; the pubescence of the declivity minutely scale-like; a larger species, length, 3·5 mm. Utah, **utahensis** Sw.

AA The mesosternum oblique between the coxæ; the antennal club very elongate with the sutures very strongly oblique; usually larger species; the intercoxal piece of the prosternum rather narrow.

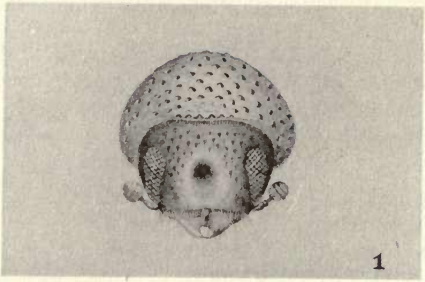
B The elytral declivity with the second interspace narrower than the 1st or 3rd, at least towards the apex; the male with the 1st interspace on the declivity unarmed or serrate only at the top of the declivity; the smooth, shining area of the proepisternum large, extending nearly to the caudal margin.

PLATE 15.

IPID STRUCTURES—All Much Enlarged. (Original.)

Fig. 1, *Pityogenes hopkinsi* Sw., front of head, female.
Fig. 2, *Pityogenes knechteli* Sw., front of head, female.
Fig. 3, *Pityogenes hopkinsi* Sw., declivity of elytra, male.
Fig. 4, *Pityogenes carinulatus* Lec., declivity of elytra, male.
Fig. 5, *Pityokteines sparsus* Lec., declivity of elytra, male.
Fig. 6, *Pityokteines sparsus* Lec., declivity of elytra, female.
Fig. 7, *Phloeosinus sequoiæ* Hopk., declivity, male.
Fig. 8, *Phloeosinus punctatus* Lec., declivity.

PLATE No. 15.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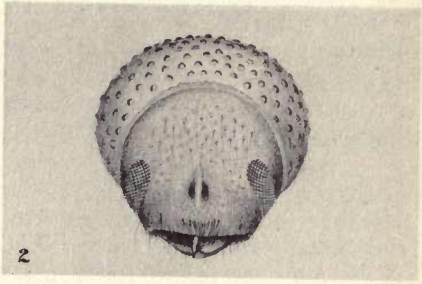
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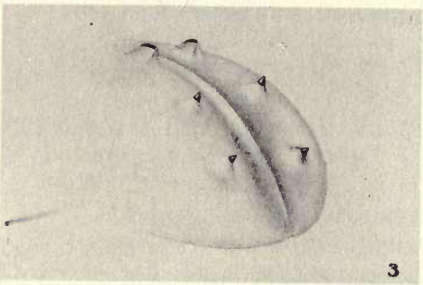
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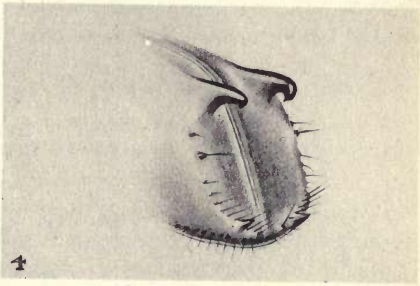
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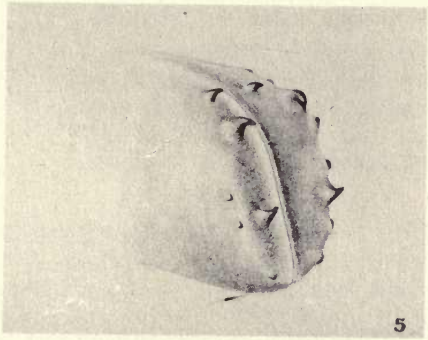
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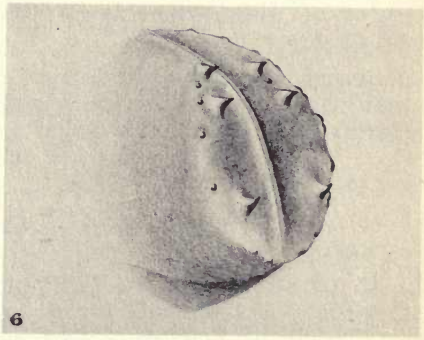
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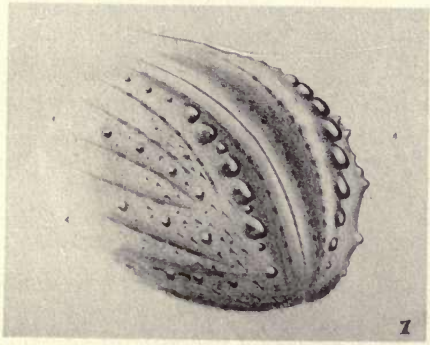
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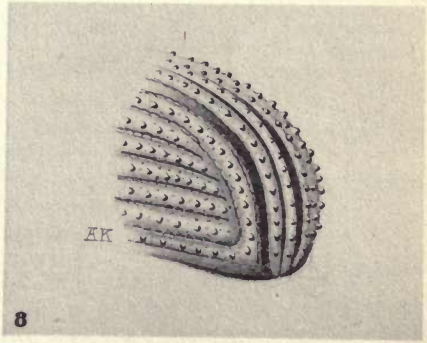
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C The elytral striæ strongly impressed on the disc, of moderate width, with the punctures coarse and very distinct; the female with the 1st and 3rd declivital interspaces subequally, strongly serrate; the male with the 1st declivital interspace coarsely serrate at the top of the declivity and unarmed behind. California.

cupressi Hopk.

CC The elytral striæ lightly impressed on the disc, very narrow, with very small punctures; the female with the 3rd declivital interspace much more strongly elevated and serrate than the 1st; the male with the 1st declivital interspace without coarse serrations.

D The interspaces of the disc and sides finely and densely granulate-punctate; the interspaces of the declivity closely, deeply and rather finely punctured, California. **cristatus** Lec.

DD The interspaces of the disc and sides rather sparsely and coarsely, transversely granulate, the punctures indistinct; the interspaces of the declivity very feebly punctured in the female, the punctures obsolete in the male.

sequoiæ Hopk. Page 70.

BB The elytral declivity with the 2nd interspace as wide as the others; the smooth, shining area of the caudal part of the proepisternum small and central.

C The elytral interspaces confusedly but rather sparsely granulate-punctate; the striæ moderately impressed, punctured more coarsely than in *juniperi*, but distinctly less coarsely than *punctatus;* the median carina and lateral callus of the pronotum seldom distinct; a smaller species, length, 3 mm. California.

rugosus Sw.

CC The elytral interspaces wider, confusedly, densely granulate-punctate; the discal striae slightly impressed, finely punctured; the median carina and lateral callus of the pronotum usually distinct; a larger species, length, 3·4 mm. California.

juniperi Sw.

Phlœosinus pini Sw.; Can. Ent., 47: 362, Nov., 1915.

A small black species, 2·5 mm. long; the female with the front flattened, coarsely rugulose-punctate and finely carinate; the male with the front similar but broadly impressed, with an obtuse elevation on each side, and the pronotum strongly broadly constricted in front.

Host tree.—Jack Pine.

Distribution.—Riding mountains, Manitoba; probably more widely distributed.

Phlœosinus punctatus Lec.; Am. Phil. Soc. Proc., 15: 381, 382, 1876.

Readily distinguished by the size, food plant, very coarse strial punctures, and narrow 2nd striæ on the declivity (Pl. 15, fig. 8).

Host trees.—Giant Arborvitæ in British Columbia; also recorded from United States in Incense Cedar and Port Orford Cedar.

Distribution.—British Columbia, extending south into California.

Phlœosinus canadensis Sw., Dom. Ent. Br., Dept. Agric., Bull. 14: 8, 1917.

A black species, length, 2·5 mm. This is the common species in arborvitæ in Eastern Canada and the adjacent northeastern States. The brood tunnels are very abundant in dying tops and branches, in weakened areas on living trees, and less commonly in apparently healthy trees. The

young adults cut short food tunnels in healthy cedar twigs. An important secondary enemy and at times a primary enemy of arborvitæ in Eastern Canada.

Host tree.—Arborvitæ.

Distribution.—Eastern Canada and Eastern United States.

Phlœosinus dentatus Say; Acad. Nat. Sci. Phil. Jour., 5: 258, 1826; ed. Lec. 2: 319.

Host tree.—Arborvitæ.

Distribution.—Represented in our collection from Texas, Tennessee, Virginia, Kentucky, Arkansas, Washington, D.C., and Massachusetts.

Phlœosinus sequoiæ Hopk.; U.S. Bur. For., Bul. 38, p. 33-35, fig. 1, pl. 12, 1903.

A large dark species, 4 mm. long; probably the common larger *Phlœosinus* of British Columbia cedar. (Pl. 15, fig. 7).

Host tree.—Giant Arborvitæ in British Columbia, and Western United States.

Distribution.—British Columbia Coast region, southwards to California.

Phlœosinus serratus Lec.; Am. Ent. Soc. Trans., 2: 169, 1868 (*Hylesinus*); Trans. Am. Phil. Soc. XV, 381, 1876.

The front is concave and finely granulate-punctate; the pronotum is densely, rather finely punctured, less finely than in *utahensis*; the elytral interspaces are very wide, and finely densely rugulose, more strongly than *utahensis*; the declivital serrations are coarse, very stout and blunt and very closely placed. Allied to *dentatus* Lec.

Known to me only through the type.

Phlœosinus haagii Eichh.; Berl. Ent. Zeitschr., 148, 1868, (*Dendroctonus*), "Amer. bor."; Chapuis, Mem. Soc. Liege, 94, 1869, (*Phlœosinus*); Leconte, Proc. Am. Phil. Soc., XV, 436, 1876 (orig. desc. quoted).

Length, 2·5 mm., "Am. bor." Unknown to me.

Phlœosinus graniger Eichh., same references.

Length, 2 mm., Texas. Unknown to me.

The Genus **Leperisinus** Reitter.

Bestimm. der Borkenkäfer, 39, 1913.

The genus *Leperisinus* was separated from *Hylesinus* Fabr. by Reitter upon the following characters: wing covers *gradually* descending behind; the venter of the abdomen elevated behind; the body scaly; the elytra finely striate on the sides; the first two sternites truncate; the second much shorter than the next two together; the tarsal furrow of the fore tibia long, attaining at least to the middle of the tibia. It was made to contain *fraxini* Panz., *orni* Fuchs, and *wachtli* Reitt., of which *fraxini* should be taken as the type. The genus is quite distinct from *Hylesinus* and *Ptelobius*, neither of which appears to be represented in our fauna.

Key to the Species.

A The antennal club oval; the pronotal and elytral colour markings transverse. **fasciatus** Lec. Page 71.

AA The antennal club elongate-fusiform; the pronotal colour-markings longitudinal, the elytral markings oblique, angulated or indistinct.

B The median interstrial row of the elytral pubescence much longer than the surrounding scales, *hairlike on the sides,* and broadly spatulate on the declivity; the sides of the prototum very strongly asperate.

C The elytral striæ and strial punctures distinct; the interspaces feebly asperate; the colour-markings indistinct; the length usually more than 3 mm. Eastern States. **imperialis** Eichh. Page 71.

CC The elytral striæ and the strial punctures largely hidden by the scales; the interspaces strongly asperate; the colour-markings very distinct; the length less than 3 mm. California, Olive trees. **californicus** Sw.

BB The median interstrial row of the elytral pubescence but little longer than the surrounding scales, not conspicuously hairlike on the sides.

C The asperities on the sides and cephalic margin of the pronotum very feebly developed.

D The scales very pale cinereous, the elytra and pronotum with indistinct, pale yellowish markings; the elytral interspaces only very feebly asperate; length, about 3 mm. **cinereus** Sw. Page 72.

DD The scales forming well-defined dark and pale markings; the elytral interspaces coarsely, closely, uniseriately asperate; length 3·5 mm. to 4 mm. **pruinosus** Eichh. Page 72.

CC The asperities on the sides and cephalic margin of the pronotum rather coarse.

D The pronotal asperities few in number, near the lateral margin, usually mostly before the middle, those of the submarginal row in front lunular; the pronotum only very feebly emarginate in front; the striæ and strial punctures distinct, with a median row of scales on the interspaces slightly longer than the others, more distinct on the declivity; the basal transverse pale band on the elytra continuous. **aculeatus** Say. Page 72.

DD The pronotal asperities numerous, extending to the caudal margin and upon the disc, those of the submarginal row in front elongate and subacute; the pronotum rather strongly emarginate on the middle line in front; the striæ and strial punctures almost entirely hidden by the scales; the median row of slightly longer scales hardly visible on the interspaces even on the declivity; the basal pale transverse band on the elytra absent on the 3rd and 5th interspaces. **criddlei,** n. sp. Page 72.

Leperisinus fasciatus Lec.; Am. Ent. Soc. Trans., 2: 170, 1868.

Length, 1·5 mm. A very beautiful little species; black, with whitish and yellowish-brown markings. It may be separated from the *aculeatus* group.

Distribution.—Pennsylvania (type); Clemmton, N.Y. (Blanchard collection).

Leperisinus imperialis Eichh.; Berl. Ent. Zeit., 149, 1868.

A large species, the colour markings of the *aculeatus* type but rather indistinct in our specimens. Apparently rare.

Recorded from Dakota, Arizona, Wisconsin, Georgia and New York. We have one specimen from New York State, and have seen a closely allied but possibly distinct species from Marin Co., California, in the collection of Mr. H. C. Fall.

Leperisinus cinereus Sw.; Dom. Ent. Br., Dept. Agric., Bull., 14: 15, 1917.

Easily separated by the characters given in the key. Apparently a rare species.

Host trees.—Ash.

Distribution.—Hudson and Ste. Anne de Bellevue, Que.; Cambridge, Roxbury, and Brooklin, Mass.

Leperisinus pruinosus Eichh.; Berl. Ent. Zeit., 149, 1868.

The species accepted here as *pruinosus* Eichh., heretofore confused with *aculeatus* Say, agrees well with Eichhoff's description.

Distribution.—Represented in our collection from Michigan, Pennsylvania, and Tennessee.

Leperisinus aculeatus Say; Acad. Nat. Sci. Phil. Jour., 3: 322, 1826; ed. Lec., 2: 181.

Length, 2·3 mm. to 3 mm.; the colour-markings usually distinct, formed of greyish and dark scales in alternate subregular bands; on the pronotum the scales greyish except on a diamond-shaped median area and an elongate lateral area; on the elytra the pale markings in three subtransverse bands across the disc and a wide band along each side, the 1st band transverse, sub-basal, the 2nd and 3rd oblique on each elytron, forming two-angled bands, angled behind; the intervening dark areas with scales coloured like the background. The male has the front more distinctly flattened and more densely hairy than the female.

Host tree.—Ash.

Distribution.—Eastern Canada, following the distribution of its host tree from Manitoba to the Maritime Provinces; Eastern United States, represented in our collection from Michigan and Kansas eastward through New York state and Massachusetts.

The brood tunnels are very abundant in dying and recently killed trunks and limbs; short hibernating tunnels are cut in the middle bark of living trunks; a secondary enemy; often nearly exterminated in a limited locality by hymenopterous parasites and mites.

Leperisinus criddlei n. sp.

Length, 2 mm. to 2·6 mm.; of smaller average size than *aculeatus* Say, with distinct colour-markings and characters as given in the key.

Type; Aweme, Manitoba; 21-VII-1915; 8178; N. Criddle, Type No. 102.

Host trees.—Green Ash, White Ash.

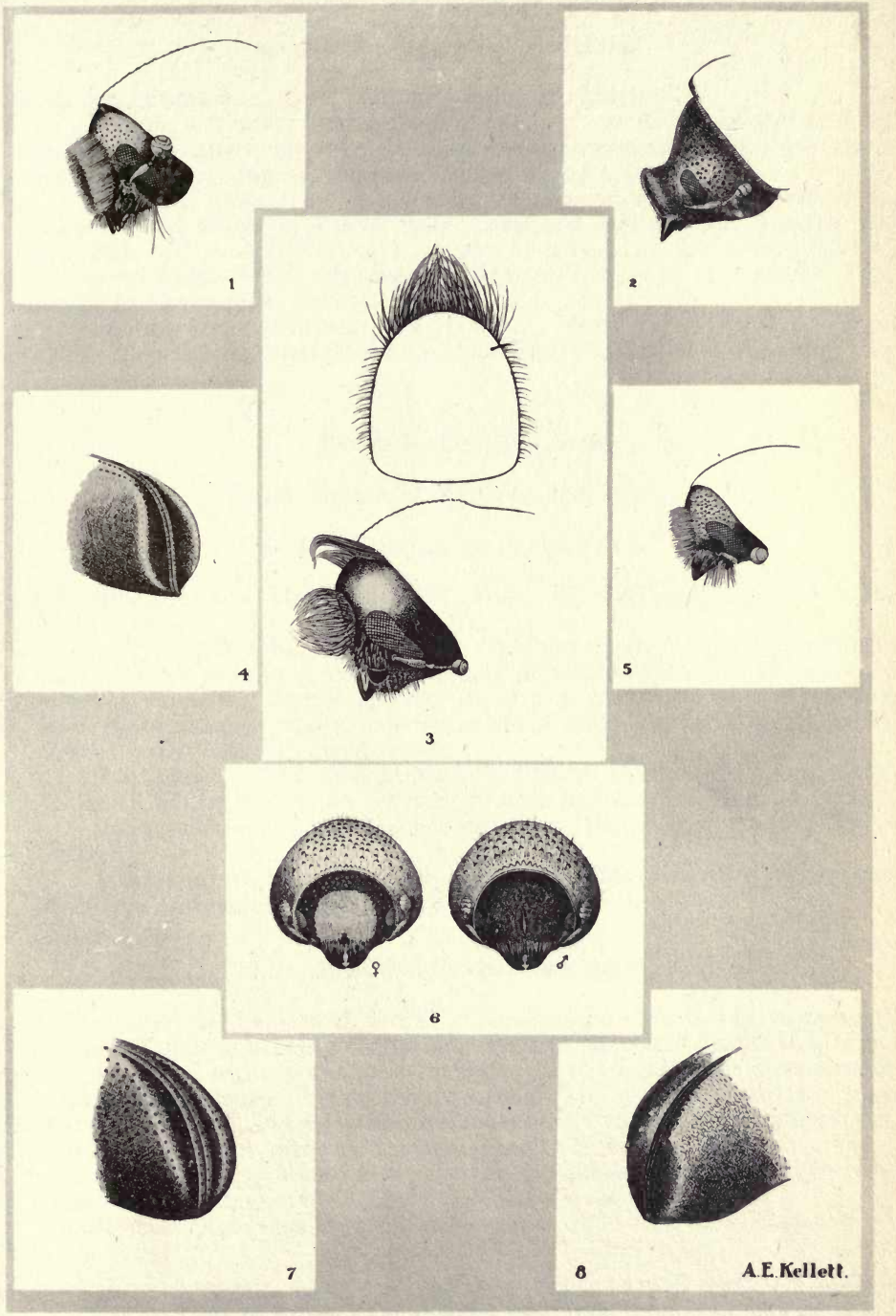
Distribution.—Aweme, Man.; St. Hilaire, Que.

PLATE 16.

IPID STRUCTURES—All Much Enlarged. (Original.) A.E.K.

Fig. 1, *Dryocoetes confusus* Sw., head from the side, female.
Fig. 2, *Ips tridens* Mannh., head from the side, female.
Fig. 3, *Pityokteines sparsus* Lec., head from the side, and pronotum from above, female.
Fig. 4, *Pityophthorus nudus* Sw., elytral declivity.
Fig. 5, *Dryocoetes affaber* Mannh., head from the side.
Fig. 6, *Pityophthorus canadensis* Sw., head from the front; male and female.
Fig. 7, *Pityophthorus pulicarius* Zimm., elytral declivity.
Fig. 8, *Pityophthorus canadensis* Sw., elytral declivity, female.

PLATE No. 16.



The Genus **Scierus** Leconte

Am. Phil. Soc. Proc., 15: 390.

One described species in our fauna.

Scierus annectens Lec.; Am. Phil. Soc. Proc., 15: 390, 1876.

Length, 3·6 mm.; reddish brown, opaque; pronotum wider than long, strongly punctured; elytral striæ deep, regular, with close, deep punctures; interspaces finely rugose, thinly clothed with short, yellow hairs.

Probably more than one species are represented in our collection, taken by the writer at Lesser Slave Lake and Jasper Park, Alberta, and Kelowna, B.C., but they are all left under *annectens* Lec. for the present.

Host trees.—White Spruce, Englemann's Spruce, Lodgepole Pine; probably also in Sitka Spruce.

Distribution.—Anticosti (Lec.); Lesser Slave Lake, Alberta; Jasper Park, Alberta; Kelowna B.C.; Cariboo District, British Columbia; Vancouver island (Lec.).

The Genus **Hylastinus** Bedel

Bedel, Faun. Col. Seine, 6: 388, 1888.

One described species in our fauna.

Hylastinus obscurus Marsham; Ent. Brit., 57, 1802, (*Hylesinus*); *trifolii* Muller, 1807.

Length, 2·5 mm.; shaped like *Hylurgops;* nearly black; pronotum slightly wider than long, coarsely closely punctured with smaller punctures intermixed, elytra deeply striate, punctures coarse, close and shallow, interspaces strongly rugose; side pieces of the meso-and metathorax densely clothed with yellow, fringed scales.

Host plants.—Red and Mammoth Clover, Alsike (less commonly), White Dutch, and Sainfoin (cutting tunnels but not breeding) in Canada.

Distribution.—Southern Quebec, southern Ontario, and Eastern United States.

A most injurious species, tunnelling the roots of clovers, particularly of the red and mammoth varieties (Pl. 5, fig. 4).

The Genus **Alniphagus,** new genus.

Of medium size, antennal funicle 7-segmented, club feebly compressed, with sutures 1 and 2 strongly chitinized, last two segments longer than 2 and rapidly narrowed, segments of club indistinctly subdivided by a constriction and a row of hairs; beak short; pronotum strongly muricate on the sides in front; side pieces of the meso-and metathorax densely scaly; forecoxæ widely separated; proventriculus without distinct diagonal lines, the costal teeth numerous at the base of the bristles, its disc finely sparsely granulate, chitinized on the sides, the transverse lines strong; the ligula rounded at the apex.

The type is *Hylesinus aspericollis* Leconte, 1876, the only species in our fauna.

Alniphagus aspericollis Lec.; Am. Phil. Soc. Proc., 15: 379, 1876, (*Hylesinus*).

Length, 3·5 to 4 mm.; the median epistomal lobe wide, the pronotum with small punctures and decidedly muricate, more strongly in front; scutellum minute, depressed; the elytral striæ strongly impressed and

coarsely punctured; the interspaces convex, minutely granulate-punctate and uniseriately asperate; the alternate intervals wider and strongly convex on the declivity; the side pieces of meso-and metathorax densely scaly.

Host tree.—Western Alder.

Distribution.—Coast and southern interior of British Columbia, and southward to California.

The Genus **Hylurgopinus,** new genus.

Of medium size; antennal funicle 7-segmented, club feebly compressed, sutures 1 and 2 strongly chitinized, last two segments longer than 2; beak short; protonum coarsely, irregularly punctured, not impressed; forecoxæ widely separated; metepisternum without dense scales; proventriculus with costal teeth almost obsolete, the disc finely, densely granulate, the transverse lines indistinct, chitinized on the sides.

The type is *Hylastes rufipes* Eichh., the only species known in our fauna.

Hylurgopinus rufipes Eichh.; Berl. Ent. Zeit., 147, 1868, (*Hylastes*); *opaculus* Lec., 1868 (*Hylesinus*).

Length, 3·25 to 3·75 mm., the epistomal lobe nearly as long as wide; the pronotal punctures coarse, close and irregular; elytral striæ deep, punctures coarse, close and deep; interspaces minutely punctured and with an irregular row of asperities.

Host trees.—Elm, Basswood.

Distribution.—Eastern United States; less abundant in Eastern Canada.

The Genus **Pseudohylesinus** Swaine.

Dom. Ent. Br., Dept. Agric., Bull. 14: 11, 1917.

Key to the Species.

A The first segment of the antennal club much longer than the second; the 9th interspace not strongly serrate about the declivity.

B The antennal club hardly flattened, subconical, segment 1 as long as segments 2 and 3 together; the sides of the elytra parallel on about the basal two-thirds; a large species, 5·5 mm. in length. **granulatus** Lec. Page 75.

BB The antennal club evidently flattened; stouter species, with the sides of the elytra parallel on about the basal half; smaller species.

C The vestiture slender and almost entirely hairlike on the pronotum; the scales of the elytra small and elongate, hairlike towards the base.

D The elytral interspaces strongly convex and coarsely, uniseriately asperate; the strial punctures coarse and the striæ wider; the sides of the elytra parallel on the basal half.

*E The elytra more strongly sculptured; the striæ nearly as wide as the interspaces; the elytral scales small but rather wide behind. Oregon. **nobilis** Sw.

EE The elytral striæ distinctly narrower than the interspaces; the elytral scales very elongate. **tsugæ** Sw. Page 75.

DD The elytral interspaces flat on the disc and sides; the asperities confused on the wider 3rd interspaces of the disc; the strial punctures moderate; the elytra slightly inflated behind, slightly wider behind the middle than at the base. **obesus** Sw. Page 76.

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*Barely distinct from *tsuagæ;* this may prove to be identical.

CC The vestiture of the pronotum of intermixed scales and hairs; the elytra densely scaly; the interspaces nearly flat, the striæ narrow, with small punctures; the sides of the elytra parallel on the basal half; the pronotum with shallow punctures, the scales of the pronotum abundant on the disc.

D The scales of the elytra elongate and subacuminate at the apex. Sitka spruce. **sitchensis** Sw. Page 76.

DD The scales of the elytra but little longer than wide, broadly rounded at the apex, smaller and more slender towards the base in the female of *grandis* (Pl. 21, fig. 5).

E A moderately stout species with the interstrial hairs of moderate length; the basal teeth of the elytra closely placed and crescentic. Grand Fir and Douglas Fir. **grandis** Sw. Page 76.

EE A more slender species with much longer elytral hairs; the basal teeth of the elytra isolated and acute towards the sides. Shore Pine. **sericeus** Mannh. Page 76.

AA The segments of the antennal club subequal in length, the first hardly longer than the second; the basal margin of the elytra with isolated, acute, well developed teeth towards the sides. The ninth interspace strongly acutely serrate about the sides of the declivity; the elytral vestiture of small subcircular scales. **nebulosus** Lec. Page 75.

Pseudohylesinus nebulosus Lec.; Acad. Nat. Sci. Phil. Proc., 285 (*Hylesinus*), 1859.

A slender species, with strong colour-markings in dark and light reddish-brown; the male very densely clothed with stout scales; the epistomal lobe strongly developed; length, 2·8 mm.; width, 1·2 mm. The supposed female has interspace 9 on the declivity less strongly serrate, and the elytral scales decidedly elongate and becoming plumose towards the base. This species should properly form the type of a separate genus.

Host tree.—Douglas Fir.

Distribution.—Southern British Columbia, south to California. Usually a secondary enemy.

Pseudohylesinus granulatus Lec.; Am. Ent. Soc. Trans. 2: 175, 1868.

A large species; length, 5·5 mm.; the beak carinate; the antennal club only slightly compressed, the 1st segment as long as 2nd and 3rd together; the pronotum narrower than the elytra and moderately constricted in front in the *female*, nearly as wide as the elytra and strongly constricted in front in the *male;* the elytral striæ impressed, with coarse punctures; the interspaces strongly convex behind; the pubescence stout on the pronotum, scaly on the elytra, with scattered light-coloured patches; the scales small and frequently almost entirely abraded.

Host tree.—Grand Fir.

Distribution.—Nanaimo, Eberts, and Campbell River, in British Columbia, and probably more widely distributed. Recorded also from Washington, Oregon, and California.

Usually a secondary enemy.

Pseudohylesinus tsugæ Sw.; Dom. Ent. Br., Dept. Agric., Bull. 14: 11, 1917.

A stout species of moderate size and reddish-brown colour, sparsely clothed with short stout hairs, with tufted hairs on the sides and narrow scales on the declivity. Distinct from *granulatus* Lec., in the decidedly stouter form, much less densely and less strongly roughened pronotum, and the sparser elytral vestiture which becomes tufted on the sides; *granulatus*

has the elytra everywhere normally scaly. Length, 4·5 mm.; width, 2 mm., varying to 3·5 mm. and even 3 mm. in length.

Host tree.—Western Hemlock.

Distribution.—Vancouver island and coast of British Columbia. Attacks and kills healthy hemlocks; also infests injured and dying trees and slash.

Pseudohylesinus obesus Sw.; Dom. Ent. Br., Dept. Agric., Bull. 14: 15, 1917.

Length, 4·5 mm.; a stout species, gradually wider behind; the pubescence scale-like on the declivity. A rare species; known to us only from Inverness, B.C., from the collection of Rev. J. H. Keen.

Pseudohylesinus sitchensis Sw.; Dom. Ent. Br., Dept. Agric., Bull. 14: 12, 1917.

Very closely allied to *grandis*, of the same size, but more slender, with the front coarsely and less closely punctured, and the transverse impression unusually deep; the elytral scales are less dense than in *grandis* and elongate, becoming tufted behind the scutellum and notably so on the sides.

Host tree.—Sitka Spruce.

Distribution.—Vancouver island and coast of British Columbia.

Apparently a secondary enemy.

Pseudohylesinus grandis Sw.; Dom. Ent. Br., Dept. Agric., Bull. 14: 14, 1917.

A moderately stout species, densely clothed with brown and grey scales, the lighter colour on sections of the interspaces and often forming an irregular V-shaped mark on the elytra. Length, 2·8 mm. to 3·8 mm.

Host trees.—Grand Fir, Douglas Fir.

Distribution.—The southern half of the western coast of British Columbia and southwards. Apparently also in Queen Charlotte islands, but the host tree there is unknown to us.

A destructive enemy of the grand fir in certain localities.

Pseudohylesinus sericeus Mannh.; Bull. Mosc. 296, 1843, (*Hylurgus*); Leconte, Am. Ent. Soc. Trans.; 2: 170, 1868; Rhynch. 379, 1876 (*Hylesinus*).

More slender than *grandis* Sw.; with longer hairs; the pronotum of the male transverse, almost oval, the frontal lobe of the pronotum less distinct; the basal teeth of the elytra are isolated and acute; but the antennal club has the first segment distinctly longer than the second. It is in the series, *nebulosus, sericeus, sitchensis, grandis.*

Since the first part of this bulletin was published, the Leconte collection has been examined by the writer. The first specimen now in the Leconte series under *sericeus* Mannh. is evidently a specimen received from Mannerheim himself by Leconte; it bears the Sitka label, and may be accepted as definitely fixing the species. This specimen was not seen when the writer studied the Leconte collection some years ago. It is entirely distinct from *grandis* Sw.

PLATE 17.

IPID BEETLES—All Much Enlarged.

Fig. 1, *Ips tridens* Mannh., female*.
Fig. 2, *Ips chagnoni* Sw.*.
Fig. 3, *Ips engelmanni* Sw., female*.
Fig. 4, *Ips pilifrons* Sw., female*.
Fig. 5, *Ips latidens* Lec*.
Fig. 6, *Hylastes salebrosus* Eichh.*, details of the elytra.
Fig. 7, *Ips pini* Say**.
Fig. 8, *Hylastes porculus* Er*, details of the elytra.
Fig. 9, *Ips calligraphus* Germ*.
Fig. 10, *Eccoptogaster piceæ* Sw., male.**
Fig. 11, *Ips calligraphus* Germ*.

*Original. **Author's illustration.

PLATE No. 17.

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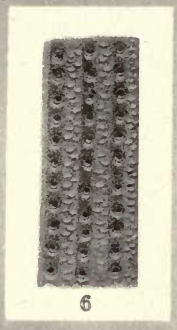
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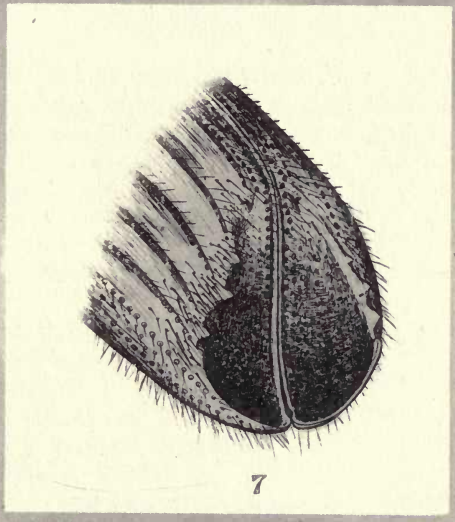
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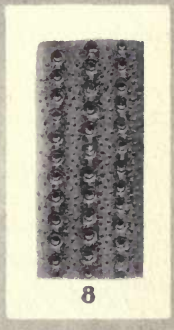
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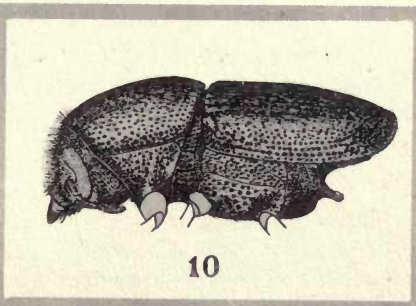
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Host tree.—Shore Pine.

Distribution.—Coast of Alaska and probably southward along the coast to California.

The Genus **Hylastes** Erichson.

Wieg. Archiv., 2: 47, 1836.

The names *Hylastes* Er., *Tomicus* Latr., 1802, and *Myelophilus* Eichh. (*Blastophagus* Eichh) have been applied in different ways. The type of the genus *Hylastes* Erichson, 1836, is *Bostrichus ater* Paykull; the type of *Tomicus* Latreille, 1802, is *H. piniperda* Fabr.; the type of *Myelophilus* Eichh., 1878, is *D. piniperda* Linn. It is evident that *Tomicus* Latreille, 1802, should be used for the allies of *piniperda* Fab., and either that *Hylastes* Er. or *Myelophilus* Eichh. should be submerged.

Several prominent European writers, including Bedel, Tredl and Hagedorn, have considered *piniperda* Fab. distinct from *piniperda* Linn. and the same as *ater* Paykull. If this were accepted *Hylastes* Er. should give place to *Tomicus* Lat., 1802. Other authors, notably Hopkins, 1915, regard *piniperda* Fabr. and *piniperda* Linn. as the same, and consider *ater* Paykull a good species. According to this interpretation *Tomicus* would replace *Myelophilus* Eichh. and *Hylastes* Er. would stand, with *ater* Paykull as type.

In my catalogue, 1909, the former interpretation was accepted, and it is probably correct; in the present paper, however, *Hylastes* Er. is used, solely to avoid confusion, since it is not possible to be certain of the matter, and *Hylastes* has been used almost invariably by recent authors.

Key to the Species.

A The beak with a distinct median carina.

B Larger and stouter species, length, more than 4 mm.; the pubescence very minute, more distinct in the *macer* group.

C The strial punctures very small, at the bottom of very narrow deep striæ which are separated by very coarsely rugose and strongly convex interspaces; the tibial teeth few and extremely coarse; the sutural striæ hardly wider than the others (Pl. 17, fig. 6). Eastern and Southern United States.
salebrosus Eichh.

CC The strial punctures coarse or small between moderately convex interspaces, or small between flattened wider interspaces; the tibial teeth only moderately coarse (Pl. 17, fig. 8).

D The interspaces distinctly convex on the disc and declivity; the pronotum usually at its widest part but little narrower than the elytra.

E The head and pronotum roughly, rather coarsely punctured, the body variably shining.

F The elytral interspaces densely coarsely rugose.

G The elytral striæ strongly impressed; the strial punctures coarse, as wide as the narrow interspaces on the disc, the pronotal punctures very coarse and only moderately close. Southern United States.
scaber Sw.

GG The elytral striæ moderately impressed on disc and declivity, only very faintly on the sides; the strial punctures rather small, narrower than the interspaces on the disc; the pronotal punctures of medium size and very closely placed. Colorado. **asper** Sw.

FF The interspaces rather finely granulate.

G The pronotum widest at the middle, the sides straight, evidently narrowed from the middle to the caudal angles; the elytral interspaces rather strongly convex on disc and declivity, finely granulate, and usually distinctly wider than the striæ; the last ventral moderately punctured not coarsely rugose. (Pl. 21, fig. 2). Eastern species.
porculus Er.* Page 79.

GG The pronotum with the sides nearly parallel on the caudal half, broadly rounded at the hind angles, strongly narrowed in front; the elytral interspaces only moderately convex rather coarsely granulate, and usually narrower than the wide striæ; the last ventral coarsely rugose-punctate. Western species.
nigrinus Mannh. Page 79.

EE The head and pronotum very finely smoothly punctured, neither roughened nor granulate; very brightly polished. New Mexico.
nitidus Sw.

DD The interspaces flat or nearly so on the disc and sides, wider than the finely punctured striæ, which are only very feebly impressed; the sutural striæ not much wider and deeper than the others; the pronotum much narrower than the elytra.

E The pronotum very elongate, nearly parallel behind, gradually narrowed in front, moderately and not very closely punctured on the disc; length 4·5 mm. Col., N. Mexico.
longus Lec.

EE The pronotum long oval or nearly as wide as long, coarsely and rather densely punctured; seldom less than 5 mm. in length.

F A black, more elongate species; the pronotum long oval, distinctly longer than wide; the elytral interspaces faintly convex near the suture on the caudal half, and the striæ there faintly impressed.
macer Lec. Page 79.

FF A red, stouter species; the pronotum but little longer than wide, the sides subparallel for over two-thirds the length, then constricted in front; the interspaces perfectly flat on the disc and sides, with the striæ not impressed.
ruber Sw. Page 79.

BB Small, very elongate species; distinctly pubescent; length, 4 mm. or less.

C The pronotum a little narrower than the elytra, moderately, not closely and not roughly punctured; the strial punctures moderate, about as wide as the interspaces, which are coarsely granulate; the pubescence distinct but sparse and very short. Indiana, Montana, N. Mex.
gracilis Lec.

CC The pronotum very much narrower than the elytra, strongly roughened and coarsely, closely punctured; the strial punctures coarse, quadrate, rather wider than the coarsely granulate interspaces; the pubescence rather long and suberect.
longicollis n. sp. Page 79.

AA The beak not carinate; very small hairy species; the pronotum with coarse punctures and a few small punctures intermixed.

* H. *scobinosus* Eichh. is said to be distinguished from *porculus* Er. by the sides of the pronotum being gradually narrowed in front.

B A stouter species, the strial punctures coarse, the striæ wider than the interspaces, which are finely granulate and finely uniseriately tuberculate. Fla., Va., N. Car. **tenuis** Eichh.

BB Distinctly more slender; the strial punctures moderate, narrower than the densely rugose more hairy interspaces. Fla., N. Car. **exilis** Chap.

Hylastes porculus Erichson; Wieg. Archiv. 2: 49, 1836; Eichhoff and Schwarz, Proc. U.S. Nat. Mus. 16: 606, 1896.

A black species; length, 4·5 mm. The last ventral of the male impressed and pubescent on the middle line behind. The only species of the genus found in Eastern Canada. (Pl. 21, fig. 2).

Host trees.—Pines.

Distribution.—Eastern United States, from Maryland to Maine and Michigan; and Eastern Canada, west to Manitoba. Rare in Canada.

Hylastes nigrinus Mannh.; Bull. Mosc., 356, 385, (*Hylurgus*), 1852.

A black species; length, 4 mm. to 5 mm. The last ventral of the male more broadly rounded, with a densely punctured and pubescent, broad, median caudal impression. The common species of the genus in the southern interior and coast regions of British Columbia.

Host trees.—Douglas Fir, less commonly in Western White Pine and Western Hemlock, and probably other conifers.

Distribution.—The Rocky Mountain and Pacific Coast regions from Alaska to California.

Hylastes ruber Sw.; Can. Ent., 47: 367, 1916.

A red species; length, 5 mm. Rare.

Host tree.—Douglas Fir.

Distribution.—Southern interior of British Columbia; Golden, Creighton Valley.

Hylastes macer Lec.; Am. Ent. Soc. Trans., 2: 175, 1868.

A black, elongate species; length, 5 to 6 mm. The last ventral of the male impressed and pubescent behind. Entirely distinct in our fauna.

Host tree.—Engelmann's Spruce (in litt.).

Distribution.—Very rare in the southern interior of British Columbia, taken at Vernon and Kaslo; California, Nevada (our coll.), Utah, Nebraska (in litt.).

Hylastes longicollis n. sp.

Description of adult: Allied to *gracilis* Lec., but with the pronotum much narrower, the strial punctures much coarser, and more distinctly hairy; length, 3·9 mm.; width, 1·3 mm. A female.

The *head* is much as in *gracilis*, but more coarsely granulate-punctate, and abundantly clothed with rather short reclining hairs above, and denser, longer hairs below, with a few longest and erect; the basal segment of the antennal club comprising nearly two-thirds the mass; the beak widened at the tip; the transverse impression stronger at the middle; the carina well developed; the epistoma not much impressed and coarsely granulate. The *pronotum* is much narrower than in *gracilis*, one-sixth longer than wide; very much narrower than the elytra; the sides straight behind, divergent to the widest point just before the middle, then arcuately narrowed to the very broadly rounded front margin; the hind margin nearly straight; the disc evenly, very coarsely and densely punctured, more finely in front and on the sides, not much roughened; with a long narrow, well developed median carina. The *elytra* are nearly straight at the base; with the sides straight for over two-thirds the length, then very strongly narrowed to the narrow but broadly rounded hind margin, as seen from above; the striæ moderately impressed, faintly on the sides, with the strial margins unusually

regular; the punctures coarse, deep, quadrate, extremely close so that the partitions are thin transverse ridges, somewhat smaller at the sides; the interspaces narrower than the striæ on the disc, wider on the sides, flattened although somewhat elevated on the disc from the depth of the striæ; finely, densely granulate-punctate, more coarsely granulate on the declivity, and evidently pubescent with short yellow hairs, longer on the declivity.

The venter is coarsely, densely punctured; the last ventral slightly convex, densely, coarsely, roughly punctured, rather narrowly rounded behind, and pubescent towards the hind margin, probably impressed behind in the male as in *gracilis* Lec.; the prothorax below very coarsely, densely and roughly but distinctly punctured.

Host trees.—Unknown. Type locality, Atlanta, Idaho. Type No. 102. We have one doubtful record from southern British Columbia.

An undescribed species of *Hylastes* occurs in *Abies nobilis* in Oregon. We have only one specimen.

The Genus **Hylurgops** Leconte.

Leconte, Am. Phil. Soc. Proc., 15: 389, 1876.

Key to the Species.

A Bases of the elytra only moderately arcuate and not serrate; the elytral interspaces subequally sculptured.

B The pronotum as wide as the elytra, margined at the sides, from acutely to subacutely, from the base nearly to the apex; densely clothed with long erect hairs on the upper surface. N. Mexico. **grandicollis** Sw.

BB The pronotum narrower than the elytra and not acutely margined at the sides; the long hairs sparse.

C Stout species; the elytra subinflated behind; the pronotum deeply sinuate on the sides in front; the mesosternum strongly protuberant; the third tarsal segment strongly widened and deeply bilobed; the pronotum rather strongly margined at the base.

PLATE 18.

IPID BEETLES—All Much Enlarged.

Fig. 1, *Hylurgops pinifex* Fitch*.
Fig. 2, *Hylurgops pinifex* Fitch*.
Fig. 3, *Hylurgops rugipennis* Mannh*.
Fig. 4, *Hylurgops subcostulatus* Mannh.*
Fig. 5, *Platypus wilsoni* Sw., antenna**.
Fig. 6, *Trypodendron betulæ* Sw.; male above, female below*.
Fig. 7, *Trypodendron retusus* Lec.; male above, female below.*
Fig. 8, *Ips calligraphus* Germ*.
Fig. 9, *Ips calligraphus* Germ.*
Fig. 10, *Dendroctonus;* proventriculus, showing diagonal lines on the disc*.
Fig. 11, *Leperisinus californicus* Sw**.
Fig. 12, *Leperisinus aculeatus* Say, pair, starting a tunnel*.
Fig. 13, *Anisandrus pyri* Peck*.
Fig. 14, *Anisandrus minor* Sw.*
Fig. 15, *Anisandrus populi* Sw*.
Fig. 16, *Anisandrus obesus* Lec*.
Fig. 17, *Gnathotrichus retusus* Lec**.

*Original. Author's illustration.

PLATE No. 18.

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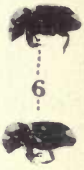
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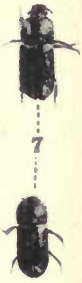
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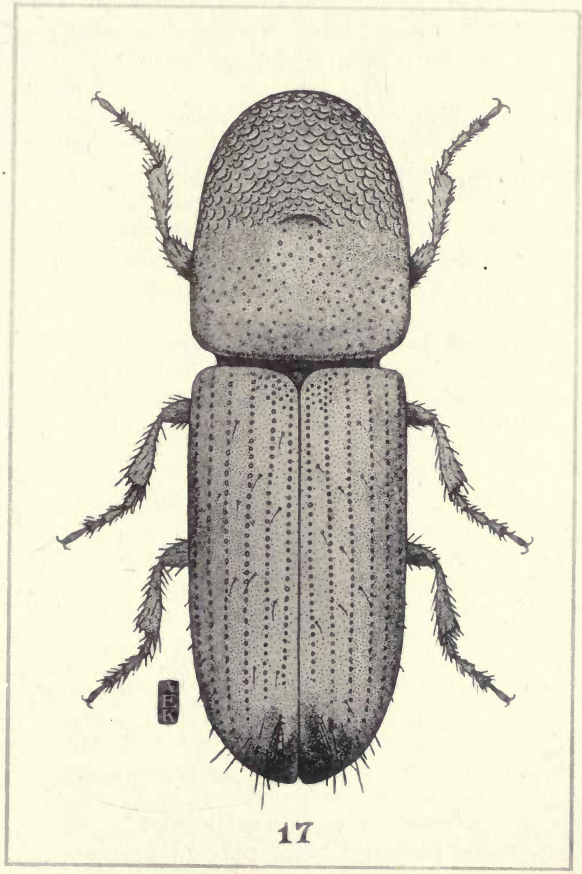
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D Larger and stouter species; the pronotum closely punctured with large and small punctures intermixed; strial punctures small, distinct, with sides approximately straight; interspaces rather sparsely, moderately rugose; epistomal carina distinctly acute (Pl. 18, fig. 2). **pinifex** Fitch. Page 81.

DD Smaller species, the pronotum densely, rather regularly punctured; strial punctures rather coarse and indistinct, interspaces closely, coarsely rugose; epistomal carina usually a narrowly convex ridge (Pl. 18, fig. 3). **rugipennis** Mannh. Page 81.

CC Rather slender species; not inflated behind; the pronotum at most only slightly sinuate on the sides in front; the mesosternum only moderately protuberant; the third tarsal segment only moderately widened; the pronotum rather feebly margined at the base.

D The pronotal punctures small and fairly regular in size; the elytral interspaces finely granulate on the basal half. N. Mexico. **knausi** Sw.

DD The pronotal punctures notably unequal in size; the elytral interspaces rugose on the basal half.

E The pronotum with many minute and numerous medium-sized punctures intermixed; the elytra deeply striate on the disc and declivity. **porosus** Lec. Page 82.

EE The pronotum with many large and a few minute punctures intermixed, the elytra rather feebly striate. **lecontei** Sw. Page 82.

AA Bases of the elytra strongly arcuate, subacute and irregularly subserrate; the elytral interspaces alternately carinate, more strongly behind; the elytra and pronotum everywhere minutely scaly, frequently encrusted (Pl. 18, fig. 4). **subcostulatus** Mannh. Page 82.

Hylurgops pinifex Fitch; N.Y. Agric. Soc. Trans., 43, 1851 (*Hylastes*).

Length, 4·5 mm.; width, 1·8 mm.; colour reddish brown to nearly black; the pronotum a little narrower than the elytra, the sides strongly arcuate behind, strongly narrowed and constricted in front of the middle; the elytra slightly widened behind the middle, the striæ deep, the interspaces convex, granulate and asperate, more strongly on the declivity; the vestiture of minute hairs, scale-like on the declivity, with a few long erect hairs behind; the male has the declivity more densely scaly, the arcuate impression on the front deeper and wider, and the carina of the 2nd ventral segment usually more strongly developed. This species is distinguished from the closely allied *H. glabratus* Zett. of Europe by the more sparsely and more irregularly punctured pronotum, and the less strongly arcuate bases of the elytra.

Host trees.—Pines, Spruce, and Eastern Larch.

Distribution.—Eastern Canada and Eastern United States; very widely distributed.

The tunnels are usually at the base of the trunk, often extending below the surface of the ground; a secondary enemy.

Hylurgops rugipennis Mannh.; Bull. Mosc., 297, 1843, (*Hylurgus*).

Slightly smaller and more slender than *pinifex*, with the pronotum more decidedly narrower than the elytra and the asperities of the declivital interspaces coarser.

Host trees.—Sitka Spruce, Engelmann's Spruce, Western White Pine, and probably all pines and spruces within its range.

Distribution.—Alaska, British Columbia, and southwards into California.

A common secondary enemy of pines and spruces.

Hylurgops porosus Lec.; Am. Ent. Soc. Trans., 2: 175, 1868, (*Hylastes*).

A large, elongate species, with a deep frontal impression, and coarsely sculptured, hairy elytra; length, 5 mm., width, 1·8 mm.; the pronotum nearly as wide as the elytra, widest at the middle; the elytral bases feebly arcuate; the male more coarsely sculptured and more densely scaly on the declivity.

Host trees.—Western White Pine, in British Columbia, and probably other pines.

Distribution.—British Columbia (Arrowhead); Western States, Washington, California, New Mexico (in our collection), Utah (a rather distinct variation). Rare in British Columbia.

Hylurgops lecontei Sw.; Dom. Ent. Br., Dept. Agric., Bull. 14: 16, 1917.

Length, 4·1 mm.; width, 1·6 mm. Allied to *porosus* Lec., but smaller, with the pronotal punctures coarser and denser and the striæ less deeply impressed on the declivity.

Host trees.—Western Yellow Pine, and apparently also Lodgepole Pine.

Distribution.—British Columbia (Okanagan Lake, Golden, Atlin); Colorado; Nevada; New Mexico.

Hylurgops subcostulatus Mannh.; Bull. Mosc., 239, 1853, (*Hylastes*); Leconte' Am. Ent. Soc. Trans. 2: 176, 1868 (*Hylastes*), species fixed; *alternans* Chap., Syn. Scol., 22, 1869 (*Hylastes*).

Length, 3·4 to 4·5 mm.; easily distinguished by the characters given in the key; an aberrant species, removed from the true *Hylurgops* through the arcuate, subserrate bases of the elytra, the longer 2nd abdominal segment, and the alternately carinate elytral interspaces.

Host trees.—Lodgepole Pine, Western Yellow Pine, Western White Pine, and probably all species of *Pinus* within its range.

Distribution.—Coast region and southern interior of British Columbia, extending throughout Western United States into New Mexico and Arizona.

THE MICRACINÆ.

The Genus **Thysanoes** Leconte.

Am. Phil. Soc. Proc., 15: 369, 1876.

Thysanoes rigidus Lec.; loc. cit., 362 (*Cryphalus*), 1876.

Dark brown, somewhat shining; the form stout, cylindric.

The *head* with the front closely punctured, with short pubescence, deeply concave and shining below; the antennal club large, outer face with suture 1 semicircular, 2 narrowly angled, 3 more broadly angled, the funicle 6-segmented, the scape densely hairy on the outer side.

The pronotum little wider than long, convex, anterior edge not toothed, disc with a few distinct, small, acute tubercles in front of the middle, rather closely and coarsely punctured behind; strongly rounded behind, very strongly narrowed towards the rounded front margin, subtriangular from above. The elytra coarsely punctured in rows, with fine strial setæ; interspaces roughly though finely punctured with uniseriate rows of bristles, granulate on the declivity; declivity rounded, oblique, the summit near the middle of the elytra. The first two ventral segments swollen and convex, subequal and each longer than the last three together. Fore tibiæ slender,

subparallel, serrate distally on the outer margin, with a long process at the inner angle. There are three types in the Leconte collection labelled " Can.", and a fourth specimen from " Detroit, Mich."

I have seen no others of the species; it is left provisionally in *Thysanoes*.

Thysanoes fimbricornis Lec.; loc. cit. 370, 1876.

Length, 1·8 mm. The pronotum longer than wide, sparsely asperate in front, nearly smooth behind the middle; elytra with rows of small punctures, interspaces with a row of short clavate bristles; outer margin of tibiæ not serrate.

Host tree.—Hickory, in twigs.

Distribution.—Pennsylvania, not known from Canada.

The genus *Micracis* is not known from Canada, although several species occur in the Northeastern States. *M. opacicollis* Lec. is abundant in New York State in dead twigs of oak and chestnut, and an undescribed species is found at Ithaca, N.Y., in poplar shoots. It is a slender species, 1·7 mm. long; the eyes narrowly separated beneath; the elytra finely punctured in rows and clothed with short scale-like pubescence. *M. rudis* Lec. was described from Detroit, Mich., but the few subsequent records are from Indiana, District of Columbia, and southwestern Pennsylvania. Our single specimen is from Georgia. It is a short, rather stout, very coarsely sculptured species; the head deeply excavated, eyes widely separated beneath, the sutures of the club broadly curved; the elytra scarcely pubescent, coarsely and roughly punctured; length, 2·5 mm.

THE IPINÆ.

The Genus **Xyloterinus,** new genus.

The male is smaller than the female and has the front convex, not excavated as in *Trypodendron;* the antennal club has the corneous first segment entirely basal, arcuate on its front margin, not narrowly angulate and produced towards the middle; the metepisternum is narrowed and sinuate in front, with the sides parallel behind.

The type is *Bostrichus politus* Say; hitherto included in *Trypodendron* (*Xyloterus*).

Xyloterinus politus Say; Acad. Nat. Sci. Jour., 5: 256, 1828; ed. Lec. 2: 318; (*Bostrichus*).

Length, 2·8 to 3·5 mm.; dark brown to nearly black, except the elytra which are usually a nearly uniform reddish-brown; the pronotum with four slender median teeth on the front margin; slightly wider than the elytra, the summit well behind the middle, asperate in front and smooth and very finely punctured behind the summit; the elytra with the striæ nearly obsolete, visible on the sides, the strial punctures very small and not deep, not perfectly regular; the interstrial punctures smaller than but as numerous as those of the striæ, uniseriate on the disc, confused on the wider lateral interspaces; the declivital striæ impressed, the pubescence abundant but fine and rather short.

Host trees.—Beech, Maple, Birch, and other hardwood trees. In dying trunks and large branches.

Distribution.—Eastern Canada and Eastern United States.

The Genus **Trypodendron** Stephens.

Stephens, Ill. Brit. Ent., 3: 353, 1830.

Xyloterus Er.

Erichson, Wieg. Archiv., 1:60, 1836.

Key to the Species.

A The elytra strongly and regularly striate, and rather coarsely punctured; the declivity with the second interspace normal, not sulcate; the pronotum asperate-punctate on the sides behind. D.C., Pa., W. Va., N.Y., N. Mex. **scabricollis** Lec.

AA The elytra at most rather faintly striate, the striæ usually somewhat irregularly punctured; the declivity with the second interspace depressed to form a distinct sulcus; the pronotum finely punctured on the sides behind.

B The carina forming the lateral margin of the declivital sulcus wide and irregularly punctured, the pronotum entirely black, closely granulate on the median part of the disc behind; the elytral declivity distinctly hairy.

C A larger species, 3·5 mm–4 mm.; the declivital sulcus wide and deep, gradually narrowed on the caudal half; the elytra with brilliant lustre, the interspaces usually flat; the male with the cephalic margin of the pronotum broadly emarginate as viewed from above. *Populus.* **retusus** Lec. Page 85.

CC Length, 3 mm. to 3·5 mm.; the declivital sulcus rather narrow and its sides nearly parallel; the elytra with rather dull lustre, the interspaces usually noticeably convex; the male pronotum broadly arcuate in front. *Betula.* **betulæ** Sw. Page 85.

BB The carina forming the lateral wall of the declivital sulcus narrow and uniseriately punctate or granulate-punctate; the pronotum punctured across the middle line near the caudal border, at most but sparsely granulate; the declivity sparsely and indistinctly hairy.

C Interspace 2 of the declivity distinctly punctured and usually as wide as interspace 1 and interspace 3, which are distinctly granulate; the pronotum and elytra normally marked with pale bands.

D The punctures of the elytral striæ rather deep and usually rather coarse; the discal pale area of the pronotum usually extending from the base to the cephalic margin. British Columbia west of the Rockies. **cavifrons** Mannh. Page 85.

PLATE 19.

IPID TUNNELS (Original).

Fig. 1, *Dryocoetes confusus* Sw.; Tunnels in balsam, inner surface of the bark; three-fifths natural size.

Fig. 2, *Dendroctonus borealis* Hopk., Tunnels in white spruce, inner surface of the bark, showing parasitized larvae; about one-half natural size.

Fig. 3, *Ips perturbatus* Eichh.; Tunnels in white spruce, inner surface of the bark; much reduced.

Fig. 4, *Pityophthorus canadensis* Sw.; Tunnels in a white pine twig, surface of the wood; four-fifths natural size.

PLATE No. 19.

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DD The punctures of the striæ shallow and usually small; the pale band of the pronotum usually transverse and basal. **bivittatum** Kirby. Page 85.

CC Interspace 2 very narrow on the declivity and impunctate.

D The pronotum with a caudal, pale, transverse band extending to the side margins; the declivital interspaces 1 and 3 distinctly granulate; the male pronotum broadly, strongly emarginate in front as viewed from above. **borealis** Sw. Page 85.

DD The pronotum and elytra without pale bands but with an obscure, smoky, reddish median area; interspaces 1 and 3 with granules nearly obsolete.

E The striæ feebly impressed on the declivity, with the 2nd interspace only feebly sulcate; the interstrial punctures rather coarse. **rufitarsis** Ky. Page 85.

EE. The striæ strongly impressed on the declivity, with the 2nd interspace deeply sulcate; the interstrial punctures small. **ponderosæ** Sw. Page 86.

Trypodendron retusus Lec.; Am. Ent. Soc. Trans. 2: 158, 1868 (*Xyloterus*).

Host trees.—Poplars.

Distribution.—Abundant throughout Canada east of the Rockies, in dying trees; apparently less common in British Columbia. (Pl. 14, fig. 4).

Trypodendron betulæ Sw.; Can. Ent. 216, 1911.

Host trees.—Birches.

Distribution.—Ontario, Quebec, and probably in the Maritime Provinces.

Trypodendron cavifrons Mannh.; Bull. Mosc. 297, 1843 (*Bostrichus*).

Apparently distinct from *bivittatum*, but presenting confusing variations.

Host trees.—Spruce, Pine, Giant Arborvitæ, Birch, Western Alder.

Distribution.—The coast and southern interior of British Columbia and southwards.

Trypodendron bivittatum Kirby; Fauna Borealis Am., 4: 192, 1837 (*Apate*).

Length, 3 mm.; width, 1·2 mm.; black with antennæ, legs, a band on the median part of the caudal border of the pronotum, and two longitudinal stripes on the elytra yellowish brown. The common species throughout eastern Canada.

Host trees.—Spruce, Pine, Arbor Vitæ, Larch, Hemlock and Balsam.

Distribution.—Eastern Canada from the Atlantic coast to northern Alberta.

An important variation occurs in the Rockies of northern Alberta in white spruce. The colour is dark piceous to nearly black with the paler markings smoky-yellowish and often indistinct.

Trypodendron borealis Sw.; Can. Dept. Agric., Ent. Br., Bull. 14: 21, 1917.

Closely allied to *bivittatum*, but distinct by the characters given in the key.

Host trees.—White Spruce.

Distribution.—Northern Saskatchewan and northern Alberta.

Trypodendron rufitarsis Kirby; Fauna Borealis Am. 4: 193, 1837 (*Apate*); Bethune, Can. Ent., 4: 152, 1872..

Similar in size and shape to *T. bivittatum;* distinguished by colour characters, the coarsely and rather sparsely granulate front, the shallow declivital sulcus and impunctate 2nd interspace, the nearly obsolete

punctures on the sides of the pronotum behind, and the nearly obsolete declivital granules. Our type of description agrees with Kirby's type; compared by R. N. Chrystal. Our series of 50 adults appear to be distinct from *bivittatum*.

Host trees.—Spruce, and probably Jack Pine.

Distribution.—Western Ontario and northern Manitoba. The tunnels and habits are similar to those of *bivittatum*.

Trypodendron ponderosæ Sw.; Dom. Ent. Br., Dept. Agric.; Bull. 14: 22, 1917.

"This species is very closely allied to *rufitarsis* Kirby, but is distinguished by its constantly darker colour, deep shining black, with an indefinite area on the disc of the pronotum and elytra very dark reddish brown; the interstrial punctures very small; the declivital striæ very strongly impressed, with the second interspace deeply sulcate."

Host trees.—Western Yellow Pine, Engelmann's Spruce, Douglas Fir, and Mountain Balsam.

Distribution.—Southern coast and interior of British Columbia.

The Genus **Pterocyclon** Eichhoff.

Eichhoff, Berl. Ent. Zeit., 12: 276, 277, 1868.

Monarthrum Kirsch.

Kirsch, Berl. Ent. Zeit., 9: 213, 1866; (Inadequate).

Key to the Species of Northern America.

A With a prominent, well developed, submarginal epistomal process, narrow and trifid in the female, broad in the male; length, 3·5 to 4·1 mm.; declivity of male concave, of female plano-convex. California.
scutellare Lec.

AA Without a prominent, well developed epistomal process; smaller species, less than 3·5 mm.; with little sexual difference on the declivity.

B With the elytra rather densely hairy behind and on the declivity, the basal three-fourths or less or at least the central portion of the elytra pale yellow, the apex brown to nearly black.
fasciatum Say. Page 86.

BB With the caudal part of the elytra at most with few and scattered hairs, the elytra light to dark brown.

C With two widely separated denticles near the middle of the declivital face of each side near the suture; declivity oblique.
mali Fitch. Page 87.

CC With the dorsal margin of the declivity on each side swollen and bearing two small denticles; with a single minute denticle on the middle of each declivital face; the declivity vertical. California.
denteger Lec.

Pterocyclon fasciatum Say; Jour. Acad. Sci. Phil., V, 255; ed. Lec., 2: 318 (*Bostrichus*), 1825; *simile* Eichh., Berl. Ent. Zeitschr., 277, 1868; *gracile* Eichh., Rat. Tomic., 444, 1878, ♀.

Length, 2·4 mm. to 2·7 mm., reddish to dark brown with the basal three-fourths of the elytra straw yellow, and densely hairy behind. The female has the front minutely punctured and slightly concave at the middle, the declivity more evidently swollen above, and the usual characters of antenna and fore tibia.

Host trees.—Maple, Beech, Hickory, and many deciduous trees; also recorded from pine in West Virginia.

Distribution.—Eastern United States and Eastern Canada; apparently very rare north of the St. Lawrence river.

Pterocyclon mali Fitch; N.Y. Rep't. Nox. Ins. 3, No. 5, p. 8 (*Tomicus*), 1859; *longulum* Eichh., Berl. Ent. Zeit., 278, 1868.

Piceous; length, 2·2 mm. to 2·5 mm., slender; the female with the declivity rather more strongly toothed, with long hairs from the distal margin of the club, and the fore tibiæ rather finely granulate, as usual.

Host trees.—Apple, Oak, Birch, and many deciduous trees; recorded also from Pine.

Distribution.—Eastern United States, Ontario, and Quebec.

The Genus **Cryphalus** Erichson.

Erichson, Wieg. Archiv., 1: 64, 1836.

We have a very small number of species of this genus in our Canadian fauna. *C. balsameus* Hopk. is exceedingly abundant in the east; *C. approximatus* Hopk. and *C. subconcentralis* Hopk., or closely allied species, occur in British Columbia; *C. canadensis*, described herewith by Professor Chamberlain, was taken in the Selkirks at Rogers' Pass. In addition to these I have taken two variations or possibly distinct species in *Abies grandis* at Saanichton, Vancouver island. We have only a very few specimens of these western species from British Columbia. Our material had been sent to Prof. W. J. Chamberlain, who was monographing the genus. His studies have been interrupted, but in the meantime his description of the new species *canadensis* is given here.*

Key to the Species.

A The interstrial hairs of the elytra long, stiff, erect, conspicuous, very much longer than the remaining scale-like pubescence.

B The pronotal asperities confused and extending towards the base. Wash. **pubescens** Hopk.

BB The pronotal asperities in approximate, subconcentric rows. **subconcentralis** Hopk. Page 88.

AA The interstrial hairs of the elytra very short and fine, inconspicuous, but little longer than the remaining scale-like pubescence, and almost invisible except on the sides and base.

B The front feebly granulate, with a transverse, arcuate, smooth impression; the pronotum with the sides very strongly narrowed, the pronotal asperities rather small, the rugose area subtending a caudal angle of about 60°; the punctures very small and dense.

C The pronotum narrowly rounded in front; the fine interstrial hairs of the elytra somewhat more evident. **canadensis,** n. sp. Page 88.

CC The pronotum rather broadly rounded in front. Idaho. **approximatus** Hopk.

BB The front coarsely granulate, convex, with a median, shining, epistomal carina; the pronotum with the sides rather strongly arcuate, the pronotal asperities coarse, relatively numerous, the rugose area subtending a caudal angle of about 90°. **balsameus** Hopk. Page 89.

*Professor Chamberlain's descriptions of *C. amabilis and C. grandis* have appeared too late to be inserted in these keys; Can. Ent., 49: 321-323, 1917.

Cryphalus subconcentralis Hopk.; The Subfamily Cryphalinæ, U.S. Dept. Agric., Office of Secy., Rep. 99, p. 40, 1915.

Closely allied to *piceæ* Ratz. of Europe, with sparse long setæ from the elytral interspaces. Female: dark brown, length 1·8 mm.; only moderately stout, narrowly rounded in front and behind; moderately shining; the front roughly but not coarsely punctured to somewhat beyond the level of the eyes, with a strong, transverse, shining, epistomal impression, and an anterior median carina, the vertex and genæ subopaque, finely reticulate, indistinctly punctulate; the *pronotum* with the cephalic margin narrowly rounded, with two prominent, contiguous, median asperities supported by two smaller asperities on each side of them (these marginal elevations vary greatly in size and in number from 2 to 6), the rugose area reddish with the asperities rather coarse, rather sparse and hardly concentric, subtending a caudal angle of about 90°, the reddish colour extending towards the base but the rugosities not caudad of the summit, the sides and caudal area very finely punctured and granulate, with long hairs on the sides and in front; the *elytra* with the sides parallel beyond the middle then narrowed to the rather narrowly rounded apex; the striæ hardly impressed but discernable, the strial punctures round, close and shallow, the interspaces with minute, densely placed punctures, only very feebly granulate, bearing minute scales, and with a median row of sparse, long, erect hairs from coarser, evidently granulate punctures, more numerous towards and upon the declivity.

The type of this description is from *Pseudotsuga taxifolia*, Saanichton, B.C.

Host trees.—Douglas Fir, Grand Fir.

Distribution.—Saanichton peninsula (Vancouver Island), British Columbia coast, and southwards.

Our species is doubtfully referred to *subconcentralis;* some individuals appear to approach *pubescens* Hopk. which is described as distinct though the confused pronotal rugosities.

Cryphalus canadensis Chamberlain, ante page 87.

"Length, 1·8 mm.; width, 0·8 mm. body oblong, elliptical, symmetrical; brownish black, with the rugose area of the pronotum slightly reddish. Pronotum five-sixths as long as broad, rounded on the sides behind, then very strongly arcuately narrowed to the narrowly rounded front margin, broadest one-third from the base, base slightly narrower than the base of the elytra; six distinct teeth on the anterior margin of the pronotum, three on each side; pronotum with prominent asperities in a V-shaped mass, with the widest portion anteriorly and the apex near but not touching the base line; the hairs of the pronotum not very long and recumbant towards the posterior margin; the anterior edge of the pronotum with a fringe of long rather heavy bristle-like hairs; disc of the pronotum everywhere

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PLATE 20.

IPID TUNNELS (ORIGINAL).

Fig. 1, *Pseudohylesinus nebulosus* Lec., Tunnels in Douglas fir, wood surface; one-third natural size.

Fig. 2, *Leperisinus aculeatus* Say, Tunnels in ash, wood surface; about one-third natural size.

Fig. 3, *Eccoptogaster piceæ* Sw., Tunnels in white spruce, wood surface; about three-fourths natural size.

Fig. 4, *Hylurgops pinifex* Fitch, Tunnels in white pine bark, inner bark surface; about two-thirds natural size.

Fig. 5, *Dryocoetes affaber* Mannh., Tunnels in white spruce bark; much reduced.

PLATE No. 20.

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minutely closely granulate punctate and minutely pubescent. The elytra are densely clothed with short, recumbent scale-like hairs, the scales not so dense on the middle portions of the elytra, and with a small more or less shining area on the humeri which is devoid of scales, the striæ not evident, rows of punctures distinct; scattered, short, bristle-like hairs slightly longer than the general pubescence on the elytra; the ventral surface sparsely, faintly punctate and sparsely pubescent. Legs dark; antennæ lighter. Front flattened and roughened feebly."

Described from one specimen collected by me from *Abies lasiocarpa* at Rogers' Pass, British Columbia, September 28, 1915.

Cryphalus balsameus Hopk.; The Subfamily Cryphalinæ, U.S. Dept. Agric., Office of Secy., Rept. 99, p. 41.

Length, 1·5 mm. to 2 mm.; moderately stout; dark-brown, subopaque with grey pubescence; the front plano-convex, closely roughly punctured, with rather coarse hairs, strongly transversely impressed, the epistoma with the median line wide, impunctate and slightly elevated in front, forming a coarse granule on the epistomal margin; the antennal funicle 4-segmented, 1st longer than the distal three, club nearly twice as long as the funicle, with 3 distinct sutures on each side and an indistinct fourth near the base, the segments oblique and the tip obliquely truncate; the *pronotum* subtriangular, very broadly rounded and finely margined behind, widest near the caudal angles, then arcuately strongly narrowed to the rather narrowly rounded front, the cephalic margin with two wide adjacent serrations on each side, with one or two smaller lateral serrations, the median line very narrow, the disc strongly convex, the rugose area obscure reddish, delimited behind by an angle of about 90°, the asperities rather coarse, moderately numerous and not concentric, densely finely granulate-punctate on the sides and behind, the pubescence minute behind, coarser on the sides and in front; the *elytra* as wide as the pronotum and slightly more than twice as long, the sides subparallel for a little over half the length then arcuately narrowed to the rather narrowly rounded tip, rather faintly punctate-striate, the striæ rather evidently impressed towards the base, the strial punctures close, shallow, moderate in size, bearing minute setæ; interspaces densely minutely granulate-punctate, bearing minute grey scale-like pubescence not completely concealing the surface, and a median row of minute but distinct sparse setæ slightly coarser than those of the strial punctures, and much coarser and conspicuous towards the lateral margin but not upon the declivity.

The male is usually smaller than the female, about 1·5 mm. long.

Host tree.—Balsam Fir.

Distribution.—Eastern Canada and Eastern United States; widely distributed. Not taken by the writer west of the Great Lakes, though it probably occurs throughout the range of its host.

This species has usually been referred to *striatulus* Mannh. It is probably Hopkin's *balsameus*, although the latter was described as "without interspacial hairs"; both the species before me and *abietis* Ratz. of Europe, to which it is very closely allied, have a row of minute hairs on the interspaces, very distinct at the base and on the sides.

Bostrichus terminalis Mannh., Bull. Mosc. II, 298, 1843, California, is unknown to me.

It is described as "oblong, closely and deeply punctured, brownish black, with greyish, erect, small hairs, the apex of the thorax and of the elytra reddish, the elytra entire, the antennae and feet rusty red.

Length, $\frac{3}{4}$ lin., width $\frac{1}{2}$ lin. California."

It has been referred to *Cryphalus* in literature.

The Genus **Letznerella** Reitter.

Bestimmungstabelle der Borkenk., 68, 1913.

Included by Hopkins in his Genus *Ernoporides.*

L. jalappæ Letzner is occasionally imported in Jalap root from Mexico and Brazil. Not recorded from Canada.

The Genus **Procryphalus** Hopkins.

Hopkins; The Subfamily Cryphalinæ, U.S. Dept. Agric., Office of Secy., Rept. 99: 33, 1915.

Procryphalus striatulus Mannh.; Bull. Mosc., 235, 1853 (*Cryphalus*).

Original Description: " Oblongus, fuscus, opacus, pube cinerea dense vestitus; thorace pulvinato, tuberculis exasperato, antrorsum densioribus; elytris evidenter punctato-striatis, interstitiis subtiliter ruguloso-punctatis; antennis pedibusque piceis.

" Var. b. fusco-castanea; thorace rufescente, glabriusculo; elytris opacis, subsericeis; antennis pedisbusque rufo-piceis.

" Longit, $\frac{5}{6}$ lin.; Latit, $\frac{1}{2}$ lin.

" Kenai.

" *Cr. granulato* Ratz. longior, thoracis tuberculis majoribus, densioribus et elytris evidenter punctato-striatis diversus."

This species is unknown to me; it has recently been placed in *Procryphalus* by Hopkins, loc. cit.

The Genus **Trypophlœus** Fairmaire.

Gen. Col. Europe, 4: 105, 1868.

One species in our fauna.

Trypophlœus nitidus Sw.; Can. Ent., 349, 1912.

Length, 2 mm.; clothed with short, inconspicuous grey hairs of two lengths; pronotum small, subtriangular from above; the elytra with rows of punctures, striæ hardly impressed; the interspaces finely confusedly punctured, the whole body shining. The only species known from Canada.

Host tree.—Alder.

Distribution.—Weymouth, N.S.

The Genus **Gnathotrichus** Eichhoff.

Eichhoff, Berl. Ent. Zeit., p. 275, 1868.

Key to the Species.

A With the elytral declivity distinctly retuse; moderately to strongly sulcate along the suture (denticulate along the summit).

B The punctures of the pronotum and elytra very small but distinct and rather deep; the front of the head coarsely punctured; the interspaces of the elytra with the minute elytral rugulations rather sparse; the declivity very strongly retuse. **retusus** Lec. Page 91.

BB The punctures of the pronotum extremely minute, almost obsolete; the front of the head strongly convergently aciculate; the minute rugulations of the elytra very dense. **sulcatus** Lec. Page 91.

AA With the elytral declivity not distinctly retuse; only very feebly sulcate along the suture.

B The pronotum moderately rough in front; the length about 3 mm. **materiarius** Fitch. Page 91.

BB The pronotum strongly roughened in front; a very small species, length, 1·5 mm. **asperulus** Lec. Page 91.

Gnathotrichus retusus Lec.; Am. Ent. Soc. Trans., 2: 155, 1868 (*Cryphalus*).

Of the form of *materiarius*, but usually larger; length, 3·6 mm. to 3·8 mm. The female has the front of the head moderately convex, delimited above by a curved line, coarsely not densely punctured, with a smooth, slightly elevated median space ending in an acute, minute epistomal process; the antennæ with a few, long, slender, hairs from the dorsal margin of the funicle and club. The male has the front of the head with the smooth median space longitudinally, very finely and feebly aciculate towards the epistoma; with the antennal pubescence normal. (Pl. 18, fig. 17).

Host Trees.—Western Hemlock, Douglas Fir, Western Yellow Pine.

Distribution.—Generally distributed through southern British Columbia and southward through the Rocky Mountain and Pacific Coast regions.

Gnathotrichus sulcatus Lec.; Am. Ent. Soc. Trans., 2: 155, 1868 (*Cryphalus*).

Very closely allied to *retusus*, but differing in the aciculate front, more finely punctured pronotum and less strongly retuse declivity. The front of the head is convex, shining above, with a median carina on the vertex, very sparsely punctured, with the basal median area strongly, convergently aciculate, the lines meeting at the slight median emargination of the epistoma which bears a minute acute point at the base of which the median lines terminate; the antennal club and funicle with a few long, marginal hairs, in the female, with the antennal pubescence normal in the male.

Host Trees.—Grand Fir, Western Hemlock, Douglas Fir, Western White Pine.

Distribution.—Generally distributed throughout southern British Columbia, extending southwards. In sapwood and heartwood of dying and recently killed trees, and more rarely in those apparently sound.

Gnathotrichus materiarius Fitch; Nox. Ins. N.Y. 4th Rep't, 40-42, 1858, (*Tomicus*); *corthyloides* Eichh., Berl. Ent. Zeit., 273, 1868.

Length, 2·5 mm. to 3·2 mm. The male with the median, smooth, carinate space on the front minutely aciculate, and without long hairs on the antennal club and funicle; the female with the aciculation on the frontal carina but with a few very long hairs on the dorsal margin of the club and funicle.

Host Trees.—Eastern Pines, Spruces, and Eastern Larch.

Distribution.—Throughout Eastern Canada and Eastern United States; apparently less abundant west of the Great Lakes.

Gnathotrichus asperulus Lec.; Am. Ent. Soc. Trans., 2: 155, 1868 (*Cryphalus*).

A very small, slender species, 1·5 mm. long; the head flat, feebly punctured; the pronotum one-half longer than wide, strongly roughened in front, very finely sparsely punctured behind; the elytra faintly punctured in rows; the declivity rather feebly sulcate.

Host Tree.—Pinus inops, (Sz.).

Distribution.—Virginia; Washington, D.C.

Undescribed species of this genus from the Western States, represented in our collection, are not likely to occur in Canada, and are omitted.

The Genus **Conophthorus** Hopkins.

Journ. Wash. Acad. Sci., 5: 429, No. 12, 1915.

Key to the Species.

The following key is adapted from Hopkins, *loc. cit.*:—

A Elytra with strial and interstrial punctures equal or subequal in size and density on the dorsal and lateral areas; elytral punctures coarse and impressed.

B 3rd interspace of the elytral declivity distinctly granulate; the declivity not strongly impressed.

C Elytra with strial punctures confused on the dorsal area; the declivity with the 1st interspace granulate. Dull black.
resinosæ Hopk. Page 93.

CC Elytra with the strial punctures in obscure to distinct rows on the dorsal area; the declivity with 1st interspace smooth, the 3rd granulate; the pronotum dark, the elytra reddish. Oregon, in cones of *Pinus ponderosa*. Length, 3·5–3·8 mm.
ponderosæ Hopk.

BB 3rd interspace of the elytral declivity unarmed or only obscurely granulate; the declivity not strongly impressed; the pronotum dark, the elytra reddish brown; the front broad. Colorado, New Mexico and Arizona, in cones of *Pinus scopulorum*, and *P. ponderosa*. Length, 3·2 mm. to 3·5 mm. **scopulorum** Hopk.

AA Elytra with the strial and interstrial punctures unequal in density and usually in size, those of the interspaces sparsely placed and usually smaller than those of the striæ, especially on the dorsal area.
Elytra with strial punctures in obscure rows on the lateral area; pronotum with punctures of posterior area fine; punctures of elytra distinct, those of the striæ rather dense.

B The declivity with the 1st interspace granulate; the hairs moderately long and erect; black, shining; the front narrow.
coniperda Schwarz. Page 93.

BB The declivity with the 1st interspace smooth except towards the apex; the hairs long.

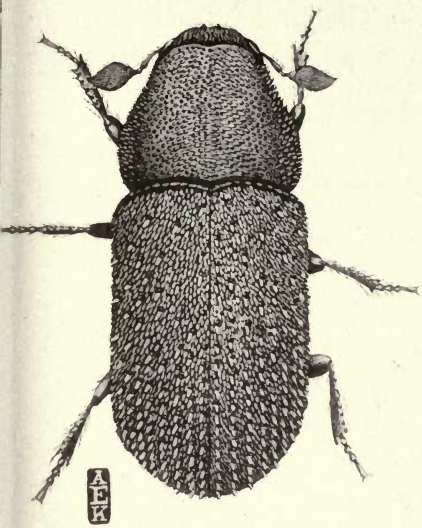
C Blackish brown, shining. Newport, Oregon, in cones of *Pinus contorta*. Length, 3·1 mm. **contortæ** Hopk.

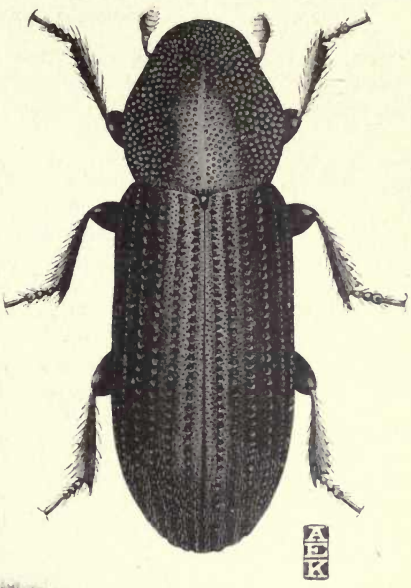
PLATE 21.

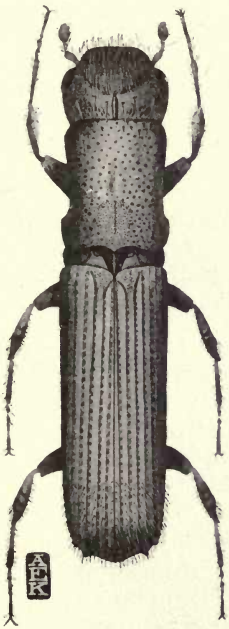
IPID BEETLES—All Greatly Enlarged. (Original.)

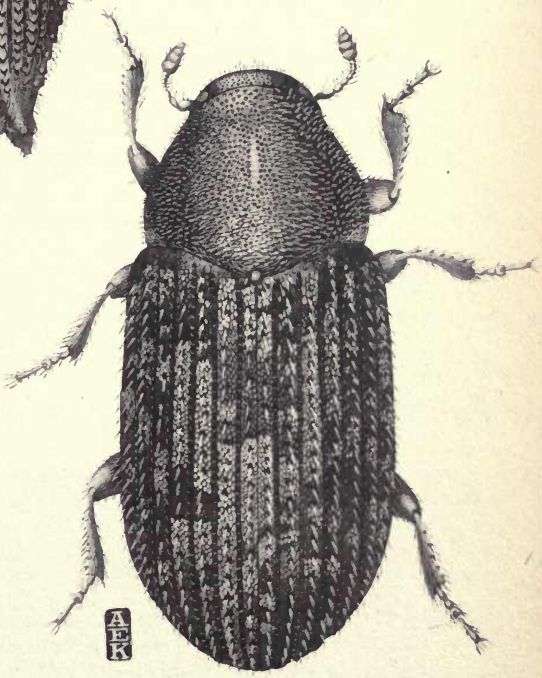
Fig. 1, *Polygraphus rufipennis* Ky. (Upper left).
Fig. 2, *Hylastes porculus* Er.
Fig. 3, *Platypus wilsoni* Sw., male, declivity of elytra.
Fig. 4, *Platypus wilsoni* Sw., female.
Fig. 5, *Pseudohylesinus grandis* Sw. (Lower right).

PLATE No. 21.









CC Pronotum black; elytra black to reddish brown.
monticolæ Hopk. Page 93.

Conophthorus resinosæ Hopk.; Jour. Wash. Acad. Sci., 5: 431, 1915.
Length, 2·75 to 3·25 mm.; recorded by Hopkins from the Harrington collection; cones of red pine; Ontario, Canada.

Conophthorus coniperda Schwarz.; Ent. Soc. Wash. Proc., 3: 144-5, 1895.
Length, 2·5 to 3·2 mm. Locally in cones of white pine from Ontario to Nova Scotia, and southwards; also less commonly in white pine buds and twigs.

Conophthorus monticolæ Hopk.; Jour. Wash. Acad. Sci., 5: 432, 1915.
Length, 2·9 to 3·8 mm. The species before me is probably Hopkins' *monticolæ*. It is closely allied to the eastern *coniperda* Sz. and mines the cones of the western white pine in a similar way. It is usually larger than *coniperda;* clothed with longer and more conspicuous bright red hairs; with the pronotum more coarsely asperate; the elytra more coarsely and deeply punctured; the interstrial punctures less numerous on the disc, usually seven to ten between the declivital summit and the base, but variable and in less regular rows; the declivity broadly, distinctly sulcate, with the suture practically without granules.

One specimen has the pronotum very strongly compressed in front so that the front margin is very narrowly and acutely rounded at the middle, and with the declivital granules coarser. It is possibly the male.

Host Tree.—Cones of Western White Pine.

Distribution.—Southern coast region of British Columbia, and on Vancouver island; southwards into the United States.

The Genus **Pseudopityophthorus,** new genus.

The type is *P. minutissimus* Zimmerman, 1868.

Generic Characters.—The antennal club with strongly arcuate sutures, the distal segments much wider than the first; the tibiæ coarsely serrate; the elytra not striate, irregularly finely punctulate; the intercoxal process of the prosternum elongate; the *male* with the front clothed with very long arcuate yellow hairs. Allied to *Pityophthorus* Eichh., in which it has been included.

Key to the Species.

A The pronotum subopaque; the elytral pubescence sparse, minute, slender, without noticeably longer hairs on the declivital face; the punctuation minute, rather sparse; the declivity only very faintly impressed on each side towards the apex; length, 1·8 mm. Eastern species.
minutissimus Zimm. Page 94.

AA The pronotum shining; the elytral declivity bearing distinctly longer hairs.

B The longer hairs of the declivital face slender, long, closely placed and conspicuous; the elytral pubescence dense and slender, often abraded; the punctuation on pronotum and elytra dense and very fine; the sutures of the antennal club strongly curved. A larger rather stout species, length, 2·5 mm. Western States. **pubipennis** Lec.

BB The hairs of the declivital face longer than on the disc and subequal in length; the elytral pubescence sparse or very short and stout; the first two sutures of the club moderately curved; smaller species, not over 2 mm. in length.

C The elytral pubescence close, short and very stout, the longer hairs of the median row on the declivity numerous and little longer than the remaining pubescence; the declivity distinctly impressed on each side the suture. Eastern species.
pruinosus Eichh. Page 94.

CC The elytral pubescence sparse, the longer hairs of the declivity slender, abundant; the declivity indistinctly broadly impressed on each side the suture, and sparsely granulate. Western States. **pilosulus** Lec.

Pseudopityophthorus minutissimus Zimm.; Am. Ent. Soc. Trans., 2: 143, 1868 (*Crypturgus*): *pusillus* Harris; Nat. Hist. Soc. Hartford Trans., 82, 1837 (*Tomicus*).

A common species in dying and dead branches and limbs.

Host Trees.—Oak and Beech in Canada; also in Hazel, and recorded from Dogwood in Eastern United States.

Distribution.—Eastern Canada and Eastern United States.

Pseudopityophthorus pruinosus Eichh.; Stet. Ent. Zeit., 39: 390, 1878; *querciperda* Sz.; Ent. Soc. Wash. Proc., 1: 56, 1888.

This species is destructive to oaks in the Eastern United States, but has not yet been recorded from Canada.

P. tomentosus Eichh. is unknown to me. It was distinguished from (*pusillus*) *minutissimus*, by Eichhoff, through its shorter form, thorax subdilated behind, and the elytral apex obliquely declivous and subretuse; "America borealis."

The Genus **Pityophthorus** Eichhoff.

Eichhoff., Berl. Ent. Zeit., 8: 39, 45, 46, 1864.

Key to the Species.

A The antennal club short oval, widest near the middle, only one-fifth longer than wide, with segments 1 and 2 together much shorter than 3 and 4 together; the sides of the club crenulate only at the base; the sutures 1 and 2 feebly arcuate, 3 very strongly arcuate (Pl. 1, fig. 4).

B The sutures of the club not septate, the margins feebly crenulate, the punctures of the elytral striæ 2 distinct on the declivity, in a straight line, interspace 2 not widened; the apex of declivity very broadly rounded, subtruncate. **ramiperda** Sw. Page 98.

BB The first two sutures of the club feebly septate; the punctures of striæ 2 very feebly developed and divergent on the declivity, so that interspace 2 is somewhat widened behind; the apex of the declivity rather narrowly rounded. (Pl. 1, figs. 4, 5. 6). **nitidus** Sw. Page 98.

AA The antennal club with the segments 1 and 2 at least nearly as long as 3 and 4; the sides of the club coarsely crenulate on more than the basal half; the segments subequal in length and the sutures often similarly arcuate (Pl. 10, fig. 22).

B Elytral declivity with striæ 1 and 2 punctured, interspace 2 not widened behind (Pl. 16, fig. 7).

C The declivity moderately or strongly sulcate along the suture, with interspace 2 impunctate, the strial punctures normally developed.

D The elytra coarsely, closely, and irregularly punctured.
pulicarius Zimm. Page 99.

DD The elytra punctured in rows.

E The pronotal asperities distinctly separated.

F The declivity with the suture strongly elevated and the elytra individually, deeply sulcate; the declivity without granules. **lautus** Eichh.

FF The declivity with the suture moderately elevated, much less so than the sides, and the elytra therefore conjointly broadly sulcate, not so deeply as in EE; the suture and sides on the declivity granulate.
rhois Sw. Page 99.

EE The pronotal asperities united to form perfectly concentric semicircular ridges; the declivity with the elytra conjointly, deeply sulcate, the suture only very feebly elevated.

F The elytral interspaces sparsely punctured near the suture; the front margin of the pronotum strongly asperate at the middle only, the declivity not granulate. Key West, Fla. **lateralis** Sw.

FF The elytral interspaces impunctate, the front margin of the pronotum feebly asperate throughout; the suture and the sides distinctly granulate on the declivity.
concentralis Eichh. Page 104.

CC The declivity only very feebly sulcate along the suture; interspace 2 feebly punctured; punctures of striæ 1 and 2 distinct but smaller than on the disc; the suture rather well elevated but smooth or nearly so; the elytra stout, one-half longer than the pronotum; minute species.

D The pronotum rather narrowly rounded and distinctly serrate on the front margin; the pronotum and elytra strongly punctured. **puberulus** Lec. Page 99.

DD The pronotum very broadly rounded and only obsoletely serrate on the front margin; the elytra very feebly punctured.
opaculus Lec. Page 99.

BB The elytral declivity with the punctures of striæ 1 and 2 becoming much smaller or nearly obsolete, with interspace 2 decidedly sulcate, shining, and usually distinctly wider than on the disc (Pl. 16, fig. 4).

C The declivity not acuminate at the apex, usually rather broadly rounded, *with the suture narrow and feebly elevated* (Pl. 16, fig. 8).

D The pronotum moderately or narrowly rounded in front and distinctly serrate; the declivity rather broadly rounded; the elytral interspaces with the punctures rather numerous.

E Rather slender species with the elytral punctures usually small and those of the interspaces usually moderately numerous; the female front clothed with very long yellow hairs, the male front with a well-developed transverse median carina, the vertical carina usually nearly obsolete.

F The declivital sulcus wide and shallow, with the lateral granules coarse or nearly obsolete.

G The pronotum narrowly or moderately rounded in front and with the two median marginal serrations distinctly larger than the others.

H The declivity closely granulate on suture and convexity; the long hairs of the female front dense and curved; the pronotal asperities coarse and subconcentric.
tuberculatus Eichh. Page 99.

HH The declivity smooth with only faint traces of granules; the long hairs of the female front straight and rather sparse; the pronotal asperities fine and irregular.
carmeli n. sp. Page 100.

GG The pronotum moderately rounded in front with the marginal serrations subequal in size; the asperities moderate and subconcentric; the strial punctures regularly placed; the declivital granules few, but distinct on suture and convexity.
pseudotsugæ n. sp. Page 99.

FF The declivital sulcus rather narrow and deep, particularly in the male; the pronotum moderately rounded and regularly serrate on the front margin, the median 6 to 10 granules subequal; the elytra strongly punctured, somewhat irregularly near the suture, the interstrial punctures rather numerous.

G The punctures of the elytral striæ usually nearly regular; the declivital sulcus with the lateral walls oblique; smaller species, 2 mm. or less in length. **atratulus** Lec. Page 101.

GG The punctures of the elytral striæ often evidently irregular near the suture, the declivital sulcus very narrow, the lateral walls perpendicular in the male; length 2 mm. to 2·5 mm.
nitidulus Lec. Page 100.

EE Stout species with punctures usually coarse and dense, those of the elytral interspaces decidedly numerous; the female front densely, finely pubescent or with hairs of moderate length, the male front with an acute, well-developed median, longitudinal carina.

PLATE 22.

BARK-BEETLE TUNNELS (ORIGINAL).

Fig. 1, *Pseudohylesinus granulatus* Lec., in lowland balsam; one-third natural size.
Fig. 2, *Ips latidens* Lec., in western white pine; one-half natural size.
Fig. 3, *Pityogenes carinulatus* Lec., in western yellow pine twigs; two-thirds natural size.
Fig. 4, *Pityogenes knechteli* Sw., in lodgepole pine; one-half natural size.
Fig. 5, *Dendroctonus simplex* Lec., in eastern larch; about one-third natural size.
Fig. 6, *Polygraphus rufipennis* Ky., in white spruce bark; portions of larger *Ips* tunnels also shown; two-thirds natural size.

PLATE No. 22.

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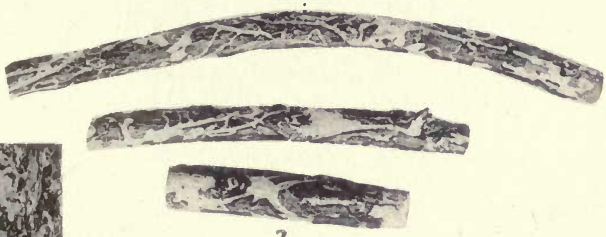
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F The female front clothed with a fringe of moderately long hairs, the declivity broadly sulcate; the male declivity more deeply, simply sulcate; the punctuation of the elytra unusually close and decidedly confused on the disc. Stouter than *cariniceps* and somewhat resembling *Conophthorus* in form and sculpture.

G The pronotum with the sides converging on the cephalic two-thirds or more, rather narrowly rounded in front; pronotum and elytra with punctures moderate in size and density.
torreyanæ n. sp. Page 101.

GG The pronotum with sides nearly straight on about the basal half, then constricted and broadly rounded in front; pronotum and elytra coarsely, densely and deeply punctured. **confinis** Lec. Page 101.

FF The female with the front densely clothed with short hairs or minute pubescence; the male with the declivity armed with a stout prominence or more elongate blunt horn from the summit of the lateral convexities.

G The female front very minutely pubescent, with a large concavity on each side of a very strongly developed acute median carina; the male with the declivital convexity of each side bearing a blunt horn directed mesad, the apices of the horns in contact at the suture. **cariniceps** Lec. Page 102.

GG The female front densely clothed with short hairs or very short pubescence, the pubescent area usually convex, in some individuals with a tendency towards the carina and concavities of *cariniceps* (Pl. 16, fig. 6); the male with the declivital convexity of each side bearing a stout prominence or sometimes a very short blunt horn, never long enough to reach the suture. **canadensis** Sw. Page 102.

DD The pronotum very broadly rounded on the front margin and only very feebly serrate; the elytral interspaces very sparsely punctured; the declivity rather narrowly rounded at the apex, and broadly sulcate; the female front densely clothed with short hairs on a circular, convex area; the declivity with the suture and lateral convexities distinctly granulate.
intextus Sw. Page 102.

CC The declivity acuminate or at least acutely rounded at the apex, as viewed from above, with a shining sulcus on each side; with the suture strongly elevated and usually granulate; the antennal club with the sutures similarly arcuate below. (Pl. 16, fig. 4).

D The punctures of the elytral striæ more or less confused towards the suture, the interspaces evidently punctured; the front of the female usually densely clothed with long hair; the last ventral deeply emarginate.

E The elytral interspaces sparsely punctured; the strial punctures in fairly regular rows, slightly confused near the suture; the declivital sulci wide and somewhat shallow.
pulchellus Eichh. Page 102.

EE The elytral interspaces closely punctured; the strial punctures irregular on the disc; the declivital sulci deep.

F The elytral declivity with the sulci very deep, the lateral convexities very strongly elevated and very closely strongly serrate along the summit.
serratus n. sp. Page 103.

FF The elytral declivity with the sulci of moderate depth, the lateral convexities moderately elevated and sparsely granulate along the summit, the punctures on the caudal half of the pronotum becoming nearly obsolete on the sides.

G The elytra twice as long as wide, the strial rows distinct on the sides and usually discernible even on the disc, the interstrial punctures rather sparse on the sides; the pronotum sparsely punctured behind.
pullus Zimm. Page 103.

GG The elytra distinctly less than twice as long as wide, the strial and interstrial punctures very close and strongly confused, those of the interspaces everywhere numerous; the pronotum closely punctured.
confertus Sw. Page 103.

DD The punctuation of the elytral disc in fairly regular rows, the interspaces impunctate or nearly so; the last ventral broadly emarginate.

E The sides of the pronotum evenly arcuate from base to apex.
bisulcatus Eichh. Page 103.

EE The sides of the pronotum more or less constricted before the middle.

F The declivity with the suture and lateral convexities strongly granulate-setose. **granulatus** Sw. Page 103.

FF The declivity with only faint traces of granules and no setæ. **nudus** Sw. Page 104.

Pityophthorus ramiperda Sw.; Dom. Ent. Br., Dept. Agric., Bull. 14: 28, 1917.

A rather stout species, 2½ times as long as wide, pronotum strongly arcuate on the sides and asperate on the sides and front, the declivity very steep, broadly rounded behind and only slightly retuse, interspace 9 elevated, discal striæ hardly impressed, strial punctures small, interspaces finely sparsely punctured; length, 2·1 mm. Probably distinct generically from both *Pityophthorus* and *Conophthorus*.

Host tree.—White Pine.

Distribution.—Isle Perrot, Que., Ste. Anne de Bellevue, Que., Chelsea, Que., Stony Creek, Ont.; probably rather widely distributed in southern Quebec and Ontario. It kills twigs by excavating tunnels in the pith as well as in the bark.

Pityophthorus nitidus Sw.; Dom. Ent. Br., Dept. Agric., Bull. 14: 25, 1917.

The length, 2·1 mm., 2⅘ times as long as wide; the *female* front flattened subcircularly, densely minutely punctured and densely pubescent with short, yellow hairs, the median carina in the form of a carinate tooth on the epistoma; the *male* front flattened but coarsely closely punctured, with the median carina well developed and pubescence indistinct.

Host tree.—White Spruce.

Distribution.—Southern Quebec, Nova Scotia.

Pityophthorus pulicarius Zimm.; Am. Ent. Soc. Trans., 2: 144, 1868 (*Cryptturgus*).

Length, 1·5 mm. to 1·8 mm.; a very distinct species by the characters given in the key. Our northern specimens are usually similar to numbers 2, 3, and 6 in Leconte's series, with the pronotum more coarsely punctured behind than in Zimmerman's type. The *female* has the front broadly flattened, very closely, finely punctured, clothed with moderately long hairs in a rather loose frontal brush; the *male* front is more strongly convex, shining, glabrous, carinate behind, the epistomal region somewhat flattened, rather finely, not very closely punctured.

P. pulicarius Zimm. approaches *Conophthorus* in habitus; but the antennal club is strongly septate; the pronotum is distinctly though not strongly asperate on the front margin, with the sides asperate on the frontal half, as in *Conophthorus*, but simply punctured behind the middle, and the transverse impression across the disc to be discerned, although very faint. This species and *ramiperda* are each intermediate in certain characters between typical *Pityophthorus* and *Conophthorus*.

Host trees.—Red Pine in Quebec, and probably other Pines.

Distribution.—Aylmer and Isle Perrot, Que., and probably also in Ontario; widely distributed in the Eastern States.

Pityophthorus rhois Sw.; Dom. Ent. Br., Dept. Agric., Bull. 14: 26, 1917.

Length, 1·6 mm., width, ·6 mm.; elytral striæ moderately impressed, coarsely punctured; the declivity steep, deeply sulcate, with striæ 2 impressed and strongly punctured.

Host tree.—Sumach, bark of dying and dead twigs and branches.

Distribution.—Eastern Canada and Eastern United States. A common species, heretofore usually confused with Leconte's *consimilis*.

Pityophthorus puberulus Lec.; Am. Ent. Soc. Trans., 2: 157, 1868.

A very small species, length, 1·3 mm., thinly clothed with short, erect, grey hairs.

Host trees.—Pines and Balsam Fir.

Distribution.—Eastern Canada and Eastern United States. Abundant in dying twigs but commonly found killing twigs on living trees after the manner of *ramiperda*.

Pityophthorus opaculus Lec.; Am. Phil. Soc. Proc., 17: 623, 1878.

Length, 1·4 mm., allied to *puberulus* Lec., but rather more slender, with the elytral punctures very much finer, finely granulate and in evident rows, with the pronotum more broadly rounded in front.

Host trees.—White Spruce, Larch, White Pine, Balsam Fir.

Distribution.—Eastern United States, and Eastern Canada west into northern Alberta.

Pityophthorus tuberculatus Eichh.; Ratio. Tomic., 498, 1878.

Length, 1·7 mm. to 2·3 mm. It has the frontal characters of the *nitidulus* group, with small elytral punctures and widely sulcate and coarsely granulate declivity; the declivity is less broadly rounded behind than usual, with the suture more strongly developed, so that the declivital characters are intermediate between *nitidulus* and *pullus*.

Pityophthorus pseudotsugæ, n. sp.

Closely allied to *tuberculatus* Eichh.; of the same size, shape, and secondary sexual characters; but differing in having the serrations on the front margin of the pronotum numerous and only very slightly larger at the middle line, the strial punctures usually regular, and the declivity with

sparsely placed and usually small granules on the lateral convexities, and very minute granules on the narrower, less elevated suture.

Type.—A female; length, 2·3 mm.; B X Mt., Vernon, B.C.; 29-VI-14, J.M.S.; *Pseudotsuga taxifolia;* 2617; fifteen paratypes, same labels. Type No. 105.

Host trees.—Douglas Fir, Alpine Fir.

Distribution.—Vernon District, British Columbia, taken in the trunk of a small dying Douglas fir, evidently a primary enemy; California.

Pityophthorus carmeli, n. sp.

Closely allied to *P. tuberculatus* Eichh. and *P. pseudotsugæ* Sw.; length, 2·6 mm.; a *female;* the front of the head very broadly moderately concave on the whole surface, finely closely punctured and somewhat sparsely clothed with nearly straight yellow hairs, shorter towards the centre and very long about the margin; the *pronotum* as long as wide, distinctly constricted in front of the middle and moderately rounded in front, the serrations of the front margin very feeble, the median pair longer, the asperities of the frontal half small and irregular, transversely impressed behind the summit, coarsely and closely punctured on the caudal half, with a smooth feebly convex median space, wider at the middle; the *elytra* twice as long as the pronotum, the striæ feebly impressed, with the punctures close, of medium size, and fairly regular; the declivity broadly sulcate, smooth and shining, with only faint traces of granules.

The *male* has the front impressed on the epistoma, with a postepistomal transverse carina, the median line smooth, upper part of front covered in our single specimen.

Type.—A female; Carmel, California; Ralph Hopping; 2934; three paratypes, two females and one male, same labels. Type No. 104.

Pityophthorus nitidulus Mannh.; Bull. Mosc., 298 (*Bostrichus*), 1843.

The Sitka specimen in the Leconte collection, bearing the label "*Bostrichus nitidulus* Mannerh.; Sitka," was probably received from Mannerheim himself, and may be accepted as fixing the species.

It is difficult to decide from Mannerheim's specimen of *nitidulus*, Leconte's descriptions and types of *atratulus* and *puncticollis*, and the available material whether we have to deal with one species, or two, or three. A study of the types of the last two species in conjunction with long series from Monterey pine of California, and pine and spruce of California, Oregon and British Columbia, leads me to believe that *atratulus* and *puncticollis* are the same. The variation in length is from 1·5 mm. to 2·4 mm. A short series from Queen Charlotte Islands, probably from Sitka spruce, slightly larger and stouter than Mannerheim's specimen are probably a variation of *nitidulus*. Until more material is available for study, especially from Northern British Columbia and Alaska, I am

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PLATE 23.

BARK-BEETLE TUNNELS (Original).

Fig. 1, *Alniphagus aspericollis* Lec., tunnels in western alder; three-fourths natural size.
Fig. 2, *Ips pini* Say, larva and pupa in the tunnels; twice natural size.
Fig. 3, *Crypturgus atomus* Lec., in white spruce bark; one and one-half natural size.
Fig. 4, 4a, *Dendroctonus simplex* Lec., in eastern larch, showing part of the brood; 4a, showing a predacious larva; one-half natural size.
Fig. 5, *Chramesus icoriae* Lec., in hickory; about natural size.
Fig. 6, 7, *Cryphalus balsameus* Hopk., tunnel in eastern balsam twigs; twice natural size.
Fig. 8, *Ips pini* Say, tunnels in a weather worn white pine branch; one-half natural size.

PLATE No. 23.

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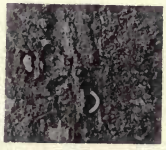
4a

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applying Mannerheim's name to the larger specimens from Queen Charlotte Islands and uniting *atratulus* and *puncticollis* under the former name for the southern smaller specimens in our collection.

Host tree.—Sitka Spruce.

Distribution.—Alaska and southward.

Pityophthorus atratulus Lec.; Am. Ent. Soc. Trans., 2: 156 (*Cryphalus*), 1868; *puncticollis* Lec.; Am. Ent. Soc. Trans., 5: 71, 1874.

Host trees.—Pines and Spruce.

Distribution.—Southern British Columbia and southwards to California.

Pityophthorus confinis Lec.; Am. Phil. Soc. Proc. 15: 354, 1876.

Length, 3 mm.; width, 1·1 mm.; piceous; coarsely, confusedly sculptured, the pubescence sparse and fine on the sides, almost invisible on the disc; a female.

The *front* is densely, deeply, rather coarsely punctured above with a flattened, somewhat semicircular area in front, densely, finely punctured and clothed with long reddish-yellow hair; the antennal club nearly as wide as long, the segments subequal, the last shorter, the sutures arcuate. The *pronotum* is about as wide as long, the sides straight and parallel on more than the caudal half, then constricted and broadly rounded in front; the front margin moderately serrate; the asperities of the cephalic half moderate in size and subconcentric; closely punctured behind; more coarsely on the disc, with a smooth median line; very strongly margined behind; the disc transversely impressed behind the summit. The *elytra* have the sides nearly straight and subparallel, moderately narrowed and broadly rounded behind; the punctuation coarse, close, and deep, decidedly confused on the disc, with the surface strongly roughened, the punctures much smaller behind near the declivity, smaller on the sides and less thoroughly confused; the declivity broadly and rather strongly sulcate, with the sulcus shining, the suture feebly elevated and finely granulate; the lateral convexities each with two rows of fine granules and fine setæ. The male has the front convex, coarsely closely punctured, impressed and more finely punctured on the epistoma, almost glabrous, with a strongly developed, longitudinal, acute, median carina, less elevated on the epistoma, and the declivity rather more deeply sulcate.

Host trees.—Western Yellow Pine, Sugar Pine, Jeffrey's Pine.

Distribution.—California.

Two entirely distinct undescribed species, closely allied to *confinis*, are represented in our collection from New Mexico.

Pityophthorus torreyanæ, n. sp.

Length, 2·5 mm.; width, 1 mm.; piceous, the punctuation close, of medium size; the declivity broadly sulcate; the pubescence rather abundant on the sides; smaller and slightly more slender than *confinis*; a female.

The *front* has a wide, subcircular area rather strongly concave, closely, finely punctured and thickly clothed with long, slender, yellow hairs. The *pronotum* very little longer than wide; the sides subregularly narrowed from the base to the rather narrowly rounded apex, only faintly constricted in front of the middle; the front margin rather feebly serrate, the median teeth longer; the asperities of the cephalic half rather small, irregular and

sparse, small and numerous about the summit; a distinct, transverse impression behind the summit; the caudal half with the punctures very close, deep, moderate in size, with a complete, smooth median line and a small smooth spot on each side. The *elytra* have the sides nearly straight, subparallel, moderately narrowed on the caudal third, rather narrowly rounded behind; the punctuation moderate in size, deep, rather close, fairly regular except near the suture where it becomes somewhat confused; smaller behind near the declivity, smaller and very dense near the sides; the declivity broadly rather feebly sulcate, the sulcus smooth and shining, the suture slightly coarser than in *confinis*, very feebly granulate-setose, the lateral convexities similarly very feebly granulate-setose in two rows, the apex distinctly more narrowly rounded than in *confinis*.

The *male* has the front of the head convex, coarsely, closely punctured; the epistoma broadly impressed, more finely punctured; the pubescence sparse and fine, closer on the epistoma; with a shining, obtuse, longitudinal, postepistomal median carina (feebly developed in some individuals).

Type.—San Diego, California; *Pinus torreyana*, female, 2945, collected by Ralph Hopping; nine paratypes, same labels. Type No. 107.

Host tree.—Pinus torreyana.

Distribution.—San Diego, California.

Pityophthorus cariniceps Lec.; Am. Phil. Soc. Proc., 15: 353, 1876.

Length, 2·5 mm. A large and very distinct species; connected with the *nitidulus* group through *canadensis*.

Host trees.—Pines.

Distribution.—Eastern United States; Nova Scotia.

Pityophthorus canadensis Sw.; Dom. Ent. Br., Dept. Agric., 14: 24, 1917.

Of the size and shape of *cariniceps* Lec., and apparently replacing that species in Quebec and Ontario.

Host trees.—White Pine and Red Pine.

Distribution.—Quebec, Ontario. Breeding in dying small branches.

Pityophthorus intextus Sw.; Dom. Ent. Br., Dept. Agric., Bull. 14: 29, 1917.

The length, 1·8 mm.; the width slightly more than one-third the length; the declivity sulcato-retuse, with long bristles.

Host trees.—Spruce and Larch.

Distribution.—Northern Alberta and northeastern British Columbia.

Pityophthorus pulchellus Eichh., Berl. Ent. Zeit., 275, 1868; *herticeps* Lec., Am. Phil. Soc. Proc., 17: 623, 665, 1878; *pusio* Lec., loc. cit.

P. pusio Lec. is known by the type and a short series from the Eastern United States. *P. herticeps* Lec. is probably the same species, and both are apparently synonymous with *pulchellus* Eichh., which is the oldest name.

The front of the male is coarsely punctured, and that of the female is densely clothed with long yellow hairs. The elytral declivity is moderately produced, with the suture well developed. It is allied to *tuberculatus* Eichh., but with the declivity more acute, the suture coarser, and the pronotum less narrowly rounded in front. Length, 1·6 mm.

Distribution.—Washington, D.C.; Pennsylvania; Long Island.

Pityophthorus serratus, n. sp.

A small, slender, strongly punctured species, strongly sulcate and serrate on the declivity, with the secondary sexual characters of the *nitidulus* group. A male; length, 2·2 mm.; colour, reddish-brown.

The *front* is closely, deeply, not coarsely punctured, broadly impressed on the epistoma, with the usual postepistomal, transverse carina. The *pronotum* is as wide as long, the sides straight and parallel on rather more than the caudal half, then constricted, broadly rounded and moderately serrate on the front margin; the asperities of the cephalic half coarse, acute, rather sparse and irregular; the punctures of the caudal half moderate, but deep and rather close, the median smooth line obsolete towards the summit. The *elytra* with the sides straight and parallel far beyond the middle, very strongly narrowed on the declivity, with the caudal margin prolonged, subacuminate; the strial punctures rather large and close, very deep, roughening the interspaces, which are similarly punctured, striæ only moderately regular near the suture; the declivity very deeply, widely sulcate, the sulci smooth, widened behind, the suture moderately wide and elevated, feebly granulate above, the lateral convexities acute and strongly, closely serrate on the 3rd interspace, with a row of rather short, stiff setæ accompanying the row of serrations; the pubescence rather long on the sides behind.

The female has the front plano-concave, minutely, densely punctured and fringed with very long, incurved, yellow hairs; with the row of setæ on the 3rd interspace of the declivity long and conspicuous in our single specimen.

Type.—A male, Barkhouse Creek, Siskiyou county, California; yellow pine limb; 2933; collector, Ralph Hopping; one paratype, female, same labels. Type No. 108.

Pityophthorus pullus Zimm.; Am. Ent. Soc. Trans., 2: 143 (*Crypturgus*).

This species occurs throughout the Eastern States, north into Michigan, in bark of pines. I have never taken it in Canada.

Pityophthorus confertus Sw.; Dom. Ent. Br., Dept., Agric., Bull. 14: 27, 1917.

Length, 2 mm.; width, 0·6 mm. The *female* with the front subcircularly plano-concave, closely, very finely punctured, closely pubescent with rather long yellow hairs, longer about the margin, with a faint median line; the *male* with the front flattened, semicircularly margined by a subtriangular callus behind, closely, deeply, not coarsely punctured, pubescence short and subequal in length.

Host tree.—Lodgepole Pine.

Distribution.—Adam's lake, British Columbia.

Pityophthorus bisulcatus Eichh.; Berl. Ent. Zeit., 274, 1868.

It has not been possible for me to connect this name, with satisfaction, with any species represented in our collection. The densely hairy front in one sex, the evenly arcuate sides of the pronotum, and the granulate and setose declivity separate it from *nudus,* and the two former characters would distinguish it from *granulatus.* It is entirely too small for *pullus* and the brief description does not apply very closely.

Pityophthorus granulatus Sw.; Dom. Ent. Br., Dept. Agric., Bull. 14: 28, 1917.

Very closely allied to *nudus,* differing chiefly in the more coarsely punctured pronotum and the strongly granulate-setose declivity.

Host trees.—Jack Pine, White Pine, Balsam Fir.

Distribution.—Manitoba, Quebec, and Nova Scotia.

Pityophthorus nudus Sw.; Dom. Ent. Br., Dept. Agric., Bull. 14: 30, 1917.

Length, 1·6 mm.; width, ·58 mm., nearly glabrous; the *female* with the front closely, finely punctured in front of a slight transverse ridge, and clothed with fine short pubescence; the *male* front closely, rather coarsely and roughly punctured, with a median carina ending in an epistomal granule, the pubescence fine and inconspicuous.

Host tree.—White Spruce.

Distribution.—Quebec, Ontario, New York State.

Pityophthorus deletus Lec. is unknown from our territory; it should be separated from *Pityophthorus*.

Pityophthorus comatus Lec. is unknown from Canada, and is apparently extremely rare in collections. It is distinguished from all other species known to me by the subcircular patch of yellow pubescence on each side of the pronotum before the middle.

Pityophthorus concentralis Eichh. was described from Cuba and is reported in literature from Florida in *Rhus metropium*. We have a short series from Biscayne and How Ck., Florida, that seem to be Eichhoff's species. They agree closely with his description in Rat. Tomic., except that the pronotum is rather too coarsely punctured behind. *P. lateralis* has the pronotum rather more finely punctured, but differs from the *concentralis* description in the punctured (sparsely) elytral interspaces.

Pityophthorus lautus Eichh. is apparently allied to *concentralis* and *rhois*. It has the declivity deeply sulcate on each side with the suture strongly elevated, and is apparently distinguished from *rhois* chiefly by that character. In *rhois* the suture is only slightly elevated on the declivity, and the elytra conjointly sulcate, although not so deeply as in *concentralis* and *lateralis;* otherwise *rhois* agrees with Eichhoff's description of *lautus* very closely. Dr. Hopkins has recognized *lautus* from W. Virginia in *Pinus*.

Pityophthorus consimilis Lec. was described from Michigan but we have not yet taken it to Canada. It is allied to *granulatus*; but has the pronotum strongly rounded on the sides behind, the discal interspaces of the elytra very sparsely punctured and the female front very densely spongy-pubescent.

Pityophthorus annectens Lec. was described from Tampa, Florida, and probably does not occur in our territory. The front is densely clothed with long hair in the female; the declivity is acuminate, feebly granulate and feebly pubescent, the elytral interspaces impunctate, the pronotum feebly constricted and feebly rounded on the sides behind.

Pityophthorus obliquus and *P. seriatus* were described from Florida, and apparently do not occur in our territory.

The Genus **Pityogenes** Bedel.

Bedel, Faun. Col. Seine, 6: 397, 401, 1888.

Key to the Species.

A The declivity oblique; the pronotum strongly narrowed on more than the cephalic half, and narrowly rounded in front; the declivity of both sexes with three small teeth on each side, considerably larger in the males (Pl. 15, figs. 1, 3).

PLATE 24.

BARK-BEETLE TUNNELS (Original).

Fig. 1, *Eccoptogaster unispinosus* Lec.; in Douglas fir; nearly one-half natural size.
Fig. 2, *Pityophthorus intextus* Sw.; in white spruce; two-thirds natural size.
Fig. 3, *Leperisinus californicus* Sw.; in olive; two-thirds natural size. Author's illustration.
Fig. 4, *Carphoborus carri* Sw.; in white spruce; three-fourths natural size.
Fig. 5, *Pseudohylesinus grandis* Sw.; in Douglas fir; one fourth natural size.

PLATE No. 24.

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B The frontal pit of the female circular, undivided.

C The pronotum with the punctures close and regular in size; the elytra finely rather closely punctured, with very fine pubescence; the frontal pit of the female very large, occupying nearly the whole cephalic half of the front, extending behind the eyes; length, 2·3 mm. Vancouver Isl., B.C., and California.

fossifrons Lec. Page 105.

CC The pronotum with the punctures sparse and irregular in size; the elytra rather sparsely punctured on the disc; the interstrial hairs coarse and long; the frontal pit of the female covering about the median third, not extending behind the eyes; length about 2 mm. Eastern Canada and Eastern United States.

hopkinsi Sw. Page 106.

BB The frontal pit of the female longer than wide, divided into two fossæ by a longitudinal median carina. **lecontei** Sw. Page 106.

AA The declivity steep; the pronotum with the sides subparallel on more than the caudal half, broadly rounded in front; the declivity with two teeth on each side, representing 2nd and 3rd of the group A, small in the female, very large and curved in the male with the upper one elongate, the tooth at the end of the second interspace obsolete in the males, nearly so in the females.

B Rather stout species; the frontal cavity of the female very large, extending behind the eyes, not divided, suboval, wider in front; the acute ridge preceding the second declivital tooth of the male strongly developed; the punctures of the pronotum and elytra rather feebly impressed, small and seldom closely placed; the pronotal asperities few and coarse. (Pl. 15, fig. 4). **carinulatus** Lec. Page 106.

BB Rather slender, the frontal cavity or pubescent spot of the female situated upon the cephalic half, and divided by a longitudinal obtuse median carina; the ridge preceding the 2nd declivital tooth of the male feebly developed.

C The declivital teeth of the male moderately slender; the front of the female with a divided, median, heartshaped cavity in front of the eyes. (Pl. 15, fig. 2). Western species.

knechteli n. sp. Page 106.

CC The declivital teeth of the male very stout; the front of the female with a subtriangular pubescent area. Eastern species.

plagiatus Lec. Page 107.

Pityogenes fossifrons Lec.; Am. Phil. Soc. Proc., 15: 353, 1876 (*Pityophthorus*); Schwarz, U.S. Nat. Mus. Proc. 18: 609, 1896 (*Pityogenes*).

Length, 2·3 mm.; black, with the declivity red. The front of the female is granulate about the sides, with the excavation very large and deep, occupying nearly the whole cephalic half; the pronotum is shaped as in *hopkinsi* Sw., much narrowed in front, coarsely, moderately closely and regularly punctured behind, more closely than in *hopkinsi*, with a narrow median carina; the elytral punctures are in approximate rows, the strial punctures fine and rather close, the interspaces rather more closely and finely granulate-punctate, the pubescence behind short and fine; the declivity with a row of three small teeth on each side, sulcate along the suture.

The type, a female, was described from British Columbia; apparently very rare. The only others I have seen are eight females, probably belonging to this species, sent by Ralph Hopping, *Pinus monticola*, Grassy Lake, Lassen Co., California; and a female and a male, sent by H. C. Fall, Sabrina Lake, Inyo Co., California.

The single male has the front convex, closely, rather finely granulate-punctate, with a fine, median, vertical carina; the elytral interspaces are less closely punctured than in the female, with a few coarse hairs behind; and the declivity is more coarsely toothed than in *hopkinsi*.

Pityogenes hopkinsi Sw.; Syr. Univ. Col. For., Tech. Pub. No. 2, 8-10, 1915; Blackman, Syr. Univ. Col. For., Tech. Publ. No. 2, 11-66, plates 1-6 (Life history and habits.)

Length, 2 mm.; black, with the elytra reddish-brown on the caudal two-thirds, legs and antennæ piceous; the *female* front with a deep subcircular impression, the declivity retuse with the sutural striæ rather deeply, widely impressed and shining, with a row of three, small, widely separated teeth on the declivital prominence of each elytron; the *male* with the front convex, coarsely granulate and closely hairy, without the median impression, the declivity strongly retuse, with the three teeth on each side coarse, the 1st compressed, curved, acute behind, the 2nd and 3rd conical and acute.

Host trees.—White Pine, Red Pine, Jack Pine, White Spruce.

Distribution.—Eastern Canada and Eastern United States.

The most abundant bark-beetle in limbs of eastern pines. Usually in collections under *sparsus* Lec.; see *Pityokteines sparsus* Lec.

Pityogenes lecontei Sw.; Syr. Univ. Col. For. Tech. Pub. No. 2, 10, 1915.

Length, 2 mm. Very closely allied to *hopkinsi*, but readily distinguished by the different frontal pit of the female. The front of the female is shining, granulate-punctate, with two elongate approximate foveæ with a combined outline longer than wide, situated on the median line at the base of the epistoma, the foveæ separated by a narrow median carina; the frontal hairs sparse and fine.

I have seen only the unique type. Probably allied to *hopkinsi* in habits.

Pityogenes carinulatus Lec.; Am. Ent. Soc. Trans., 5: 70, 1874 (*Cryphalus*); *hamatus* Lec., Am. Phil. Soc. Proc., 17: 624, 1878, *carinulatus* Lec., male.

Length, 2·9 mm. to 3·5 mm. The *female* has the large deep excavation occupying the central part of the front; the elytral declivity very steep, with a row of three small teeth on each side, the 1st minute, the 2nd and 3rd moderate, conical-acute and incurved. The *male* has the front convex, shining, closely granulate-punctate, with a wide, shining median space; the declivity very different from the female, very broadly but not deeply concave, shining, minutely punctured, acutely margined, with two teeth on each side, the upper tooth very prominent, long, slender, hooked at the tip, at the upper margin of the declivity, the lower tooth small, acute, near the apex, preceded and followed by small serrations of the acute margin, which there bears a sparse fringe of long, stiff, obliquely erect reddish hairs.

Host trees.—Western Yellow Pine, Jeffrey Pine (Hopkins).

Distribution.—Southern British Columbia, through the Western States into California and Colorado.

A very abundant secondary enemy to yellow pine in British Columbia.

The species is very abundant over an extensive range, and presents many variations. A race with rather distinct characters is represented in our collection from Colorado.

Pityogenes knechteli, n. sp.

Length, 2·8 mm.; rather slender; the front granulate-punctate, convex in the female with a divided median pit preceded by a reddish densely pubescent area; the pronotum emarginate on the sides in front, strongly

roughly punctured behind on the disc, the median line carinate, the smooth area on the side distinct; the elytra only very feebly striate, punctures in rows, those of the interspaces nearly as numerous and large as those of the striæ; the female declivity feebly convex, deeply sulcate along the suture, with two acute teeth on each side and a minute granule at the summit. The male has the front flattened, densely granulate-punctate and hairy, with a small, median, epistomal carina.

Type.—A female; Beau Vert Lake, Jasper Park, Alberta; 30-VIII-15; Lodgepole pine; 2220, J.M.S. Type No. 109.

Host tree.—Lodgepole Pine.

Distribution.—Jasper Park, Alberta, probably of wider distribution in the Rocky Mountains and Selkirks; Nechako valley, British Columbia; Atlin, B.C.

Pityogenes plagiatus Lec.; Am. Ent. Soc. Trans., 2: 161, 1868 (*Xyleborus*).

Length, 2 mm.

Host trees.—"Scrub Pine" and Southern Yellow Pine (Hopkins); Red Pine and Jack Pine (Quebec province).

Distribution.—Maryland, New York, Washington, D.C., West Virginia. Abundant in West Virginia (Hopkins); apparently less common in the northern States and Canada. A species from northern Quebec in red pine and jack pine agrees with the Leconte types except that the female has the frontal triangular area concave and pubescent. It is not separated in this memoir.

The Genus **Ips** Degeer.

DeGeer, Mem. Ins., 5: 190, 1775.

Tomicus Lat.

Latreille, Gen. Crust. Ins., 2: 276, 1807.

Key to the Species.

A The sutures of the antennal club very strongly arcuate, not angulate at the middle nor bisinuate; the punctures of the elytral striæ and interstriæ very closely uniseriate. (Pls. 10, fig. 35).

B The caudal half of the disc of the pronotum finely, densely, granulate-punctate; the elytra rather finely punctured (Pl. 14, figs. 7, 8).
concinnus Mannh. Page 111.

BB The caudal half of the disc of the pronotum rather coarsely, less closely punctured, not granulate, the surface between the punctures smooth and shining; the elytra rather coarsely punctured, the interstrial punctures as large as those of the striæ. **radiatæ** Hopk. Page 112.

AA The sutures of the antennal club nearly straight, bisinuate, or strongly angulate at the middle.

B The declivital margin with five or six teeth on each side; the produced apical margin forming much less than one-third of the circumference.

C The declivital margin with six teeth (Pl. 17, figs. 9, 11).
calligraphus Germ. Page 112.

CC The declivital margin with five teeth (Pl. 17, fig. 2).

D The punctures of the discal interspaces of the elytra very sparse or absent on the basal half and not very densely confused behind. Eastern species.

E A smaller, slender species; the pronotum decidedly elongate; the discal interspaces 2, 3 and 4 impunctate on usually the basal two-thirds, uniseriately punctured behind, but little confused near the declivity. Southern States, north to Massachusetts. (Pl. 14, fig. 3).
grandicollis Eichh. Page 113.

EE Larger and stouter and more coarsely sculptured; the pronotum only moderately longer than wide, the discal interspaces very sparsely punctured on the basal half, closely punctured on the caudal half and decidedly confused towards the declivity (Pl. 17, fig. 2). Eastern Canada.
chagnoni Sw. Page 113.

DD The discal interspaces, 2, 3 and 4, punctured throughout, the punctures uniseriate towards the base, more numerous and densely confused behind the middle. Western species.

E The hinder half of the pronotum sparsely, rather finely punctured on the disc, closely punctured on the sides; the interstrial punctures of the elytra small, much smaller than those of the striæ, the first declivital tooth about as near to the suture as to the second tooth; the declivital face finely hairy. **confusus** Lec. Page 113.

EE The hinder half of the pronotum closely coarsely punctured on the disc, densely punctured on the sides; the interstrial punctures more numerous and coarse, nearly as large as those of the striæ; the first declivital tooth placed very close to the second and distant from the suture; the declivital face coarsely densely hairy.
vancouveri Sw. Page 113.

BB The declivital margin with four declivital teeth; or, rarely, with only three declivital teeth.

C The third declivital tooth the longest, compressed, wide, emarginate at the tip.

D The discal interspaces impunctate; the conical fourth tooth usually obsolete (Pl. 13, figs. 1, 2).
emarginatus Lec. Page 113.

DD The discal interspaces closely, coarsely punctured; the fourth tooth normally present, between the third and the apical elevated margin. New Mexico. **knausi** Sw.

CC The third tooth usually cylindric or conical, never flattened and emarginate at the tip.

D The declivity nearly vertical, three teeth on each side, the third tooth longest and the last, the second followed by an acute ridge but not joined to the third; the epistoma deeply emarginate in the male; the sutures of the club only faintly bisinuate; the elytral punctures decreasing in size towards the base.

E The interstrial punctures of the elytra about as coarse as those of the striæ on the sides and on the caudal half of the disc; the pronotal punctures sparse; the female with the epistoma broadly emarginate. **longidens** Sw. Page 114.

PLATE 25.

Ips pini Say, in white pine, the inner surface of the bark; about one-third natural size (Original).

PLATE No. 25.

EE The interstrial punctures small except near the declivital margin; the pronotal punctures close upon the sides; the female with the epistoma entire. (Pl. 17, fig. 5).
latidens Lec. Page 114.

DD The declivity more oblique, with four teeth on each side, of which the third is usually longest, at least in the male, and connected at the base with the second by an arcuate ridge; the club usually with one or more sutures strongly bisinuate or very strongly angulate at the middle; the epistoma entire; the elytral punctures not decreasing gradually in size towards the base (Pl. 17, fig. 7).

E The sutures of the club very strongly angulate at the middle (Fig. 5, p. 29.) Beetles of large size and coarse sculpture.

F A larger species with coarser sculpture; length usually 5 mm. to 5·5 mm.; the form stouter; punctuation of the elytra deep, coarse and subquadrate; the declivital armature coarser.
integer Eichh. Page 114.

FF A smaller and more slender form, 4·3 mm. to 5 mm. in length; punctuation of elytra moderate and armature finer. Doubtfully distinct. (Pl. 13, fig. 4).
plastographus Lec. Page 114.

EE The first suture of the club bisinuate or nearly straight, the second more or less strongly bisinuate or angled at the middle (Pl. 10, fig. 10).

F The discal interspaces impunctate except near the declivity, rarely punctured on the 1st and 2nd.

G Larger, 4 mm. to 5·5 mm., stout, elytral disc little longer than pronotum; striæ usually impressed, with interspaces convex; pronotum very short and stout, not longer than wide; declivital teeth stouter; 1st two interspaces granulate punctate, hairy to the base; the pronotum sparsely, finely punctured behind; the pubescence erect, abundant; the profile of the elytral suture on the disc strongly arcuate.
perturbatus Eichh. (*hudsonicus* Lec.) Page 115.

GG Smaller, more slender species; the striæ usually only slightly or not at all impressed; the first two interspaces not granulate and hairy to the base; the elytral suture in profile straight on the basal half.

H Size very small, length, 2·3 mm. to 2·8 mm.; the last three declivital teeth subequal. Southern United States. **avulsus** Lec. Page 115.

HH Larger species, length usually over 3 mm.; the last declivital tooth smaller than the 2nd or 3rd.

I The pronotum evidently longer than wide, the punctures of the discal striæ much smaller near the declivity. Eastern species.

J The pronotum arcuate on the sides, the punctures small, the asperities of the cephalic half small, close and arcuate; the elytral striæ usually not impressed, the 2nd inter-

space wide behind, not punctured except at the caudal extremity, so that the sutural striæ are not much widened behind.
pini Say. Page 115.

JJ The pronotum with sides straight and parallel on the caudal three-fourths, the punctures and asperities usually coarse; the elytral striæ usually impressed, the 2nd interspace punctured on the caudal half making the sutural striæ evidently widened behind.
laticollis, n. sp. Page 116.

II The pronotum nearly or quite as wide as long; the punctures of the discal striæ but little smaller towards the declivity; the sutural striæ always widened behind by punctuations of the caudal half of the 2nd interspaces.

J The pronotum widest at the base, faintly arcuate on the sides, the punctures coarse and the asperities more commonly sparse and obtuse; the elytral striæ usually distinctly impressed and the interspaces convex. **interpunctus** Eichh. Page 116.

JJ The pronotum with the sides parallel on more than the caudal two-thirds, the punctures usually small, and asperities usually small, close and acute; the elytral striæ hardly impressed, except the sutural striæ.
oregoni Eichh. Page 117.

FF All the interspaces punctured, uniseriately except near the declivity.

G The pronotum slender, distinctly longer than wide, with the punctures nearly obsolete on the disc; discal interspaces of the elytra very sparsely punctured (Pl. 14, figs. 5, 6). **perroti** Sw. Page 117.

GG The pronotum hardly longer than wide, strongly punctured on the disc; the discal interspaces with numerous punctures.

H The front of the head almost perfectly smooth and polished, minutely and sparsely granulate and pubescent in the male, the epistomal region never more than faintly elevated; length usually less than 4 mm. **borealis** Sw. Page 117.

HH The front of the head densely or coarsely granulate or distinctly elevated on the epistomal region; the length usually more than 4 mm.

I The front of the head evenly convex.

J The punctures on the alternate interspaces of the elytra decidedly confused towards the declivity; the first two interspaces only feebly granulate behind.
hunteri Sw. Page 118.

JJ The punctures on the elytral interspaces uniseriate, at most only very little confused behind; the first two interspaces usually rather strongly granulate throughout.

K The front of the head densely, finely granulate, the strial punctures usually close and of medium size.

interruptus Eichh. Page 118.

KK The front of the head very coarsely granulate, with abundant long hairs.

L The punctures of the elytral striæ of medium size and usually rather widely separated.

dubius, n. sp. Page 119.

LL The punctures of the elytral striæ very coarse, quadrate, and very closely placed; very coarsely sculptured,

pilifrons Sw. ♂. Page 119.

II The front of the head at least distinctly elevated on the epistomal region.

J The front with a very strongly elevated, nearly naked geminate prominence on the epistomal region (Pl. 17, fig. 1).

tridens Mann. Page 119.

JJ The front of the head moderately but distinctly elevated on the epistomal region.

K The epistomal elevation stronger and clothed on the oblique cephalic face with a dense brush of hairs.

L The brush of hairs on the rather small cephalic face of the frontal elevation long and incurved; the punctures of the elytral striæ moderate in size; the length usually less than 4·5 mm. (Pl. 17, fig. 3).

engelmanni Sw. ♀. Page 120.

LL The brush of hairs on the rather large cephalic face of the frontal elevation short and extremely dense, resembling the pile on velvet; the strial punctures very large and deep; the length usually more than 4·5 mm. (Pl. 17, fig. 4).

pilifrons Sw. ♀. Page 119.

KK The epistomal elevation very moderately developed, only moderately normally pubescent, finely granulate.

yohoensis Sw. Page 120.

Ips concinnus Mannh.; Bull. Mosc., 2: 357, 1852 (*Bostrichus*); *hirsutus* Eichh., Berl. Ent. Zeit., 402, 1867 (*Tomicus*).

Length, 4·5 mm. to 5 mm.; rather elongate, with parallel sides; the sutures of the antennal club very strongly elongate-arcuate, strongly but

very narrowly recurved at the sides; the pronotum finely, densely punctured behind; the elytra shining, hardly striate, finely deeply punctured in numerous rows, the interstrial punctures nearly as large and numerous as those of the striæ, and uniseriate except on the sides and the second interspace; the declivity nearly vertical, excavated, densely deeply punctured and pubescent, with three teeth on each side, the first smallest and close to the second, the third longest, straight and stout, the acute apical margin very wide. The male has a compressed median tubercle followed by a faint carina on the front of the head; the female has the faint median frontal carina only, and the declivital armature is less coarsely developed.

Host tree.—Sitka Spruce.

Distribution.—The coast region of Alaska and British Columbia, south probably throughout the range of its host tree.

Ips radiatæ Hopk.; Proc. Ent. Soc. Wash., Vol. 17, 54, 1915.

Original description: "Pronotal and elytral punctures moderately coarse. Elytra with strial punctures not distinctly coarser than those of the interspaces." "California to Idaho, in *Pinus radiata* and *Pinus contorta.*" It is closely allied to *Ips concinnus* Mannh.

This is possibly the species before me, represented from California in *Pinus radiata* and *P. contorta;* Grant Co., Oregon, in *Pinus contorta;* and British Columbia in *Pinus contorta.* It is apparently rare in British Columbia. It is of the size and shape of *concinnus* and differs specifically from it in the following characters: The pronotum with rather coarse punctures behind, closer on the sides, a little sparser on the disc, not granulate and not roughened on the disc; the elytral punctuation nearly as in *concinnus* but distinctly coarser, and deep so that the surface is variably rugulose, the punctures of varying size near the suture; the interstrial punctures nearly as coarse as those of the striæ and somewhat irregular so that the rows of punctures are often less distinct; the declivital armature similar, but the 2nd and 3rd teeth of the male stouter than in the male of *concinnus;* the hairs on the face of the declivity minute and inconspicuous; the male front more densely granulate with the median fovea very deep and funnel-shaped.

Two specimens that are probably females of this species have the median funnel-shaped fovea of the front succeeded dorsally by a shining, shallow sulcus, and the epistomal tubercle minute; the pronotum as in the males described above, but more densely punctured; the elytral punctuation similar; the declivital teeth less coarse, the 2nd acute, followed by a faintly developed ridge, the 3rd tooth slender, cylindric, sub-capitate and sub-acute.

Ips calligraphus Germ.; Ins. Nov., 461, 1824 (*Bostrichus*); *exesus* Say, Acad. Nat. Sci. Phil. Jour. 5: 255, 1826; ed. Lec. 2: 317 (*Bostrichus*); *chloroticus* Dej., Cat. 332, 1837; *conformis* Dej., Cat. 332 (*Bostrichus*); *præmorsus* Eichh., Berl. Ent. Zeit., 401, 1867 (*Tomicus*).

The largest species of the genus in eastern Canada; length, 4·8 mm. to 6·5 mm.; the sutures of the antennal club very strongly angulate; the pronotum sparsely, finely punctured on the disc behind; the elytral striæ distinctly impressed, the sutural striæ stronger; the strial punctures close and coarse; the interspaces convex, finely uniseriately punctured on the

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PLATE 26.

Dryocoetes betulæ Hopk.; Tunnels in yellow birch; one-half natural size (Original).

PLATE No. 26.

disc, closely on the sides, densely confused and granulate near the declivity; the declivity concave, coarsely punctured, hairy, the hairs long about the sides and along the suture; with six teeth on each side arranged as shown (Pl. 17, figs. 9, 11). The male has the 3rd tooth stouter, subcapitate and curved downwards at the tip, and a shining median depression on the front of the head behind the median tubercle. There are many variations but apparently there is only one Canadian species.

Host tree.—White Pine.

Distribution.—Eastern Canada and Eastern United States. Usually found in dying trees and logs; it enters trees green enough to form pitch-tubes, and may be at times a primary enemy.

Ips grandicollis Eichh.; Berl. Ent. Zeit., 402, 1867 (*Tomicus*); *cacographus* Lec., Am. Ent. Soc. Trans., 2: 162, 1868 (*Tomicus*); *pini* (Say) Zimm., Am. Ent. Soc. Trans., 2: 147, 1868 (*Bostrichus*).

Length, 3 mm. to 3·7 mm.; a slender species with the pronotum one-third longer than wide. Represented in our collections from the southern States and as far north as Massachusetts. A closely allied undescribed species occurs in Montana and another in New Mexico. Represented in Eastern Canada by *chagnoni* Sw.

Ips chagnoni Sw.; Can. Ent., 48: 186, 1916.

Length, 4 mm. to 4·8 mm.; very closely allied to *grandicollis* Eichh., but larger, stouter, and more coarsely sculptured.

Host trees.—White Spruce, Red Pine, White Pine.

Distribution.—The provinces of Quebec and Ontario southward into New York State.

Ips confusus Lec.; Am. Phil. Soc. Proc., 15: 362, 364, 1876 (*Tomicus*): *montanus*, Eichh., Borkenk., 219, 1881 (*Tomicus*); Schwarz, Ent. Am., 2: 42 (*confusus*), 1886.

Length, 4·5 mm. Readily distinguished from the Canadian species by the characters given in the key. There are several allied undescribed species in the Western States, one of which is probably Eichhoff's *Tomicus montanus*, long considered as a synonym of *confusus*. Our material is from California and Arizona.

Ips vancouveri Sw.; Can. Ent., 48: 188, 1916.

Length, 5 mm. to 5·7 mm.; stouter than *confusus* Lec., and usually very coarsely sculptured. The face of the declivity is densely rather finely punctured and densely clothed with long slender hairs. The colour varies from dark red to black; the punctuation of the pronotum and elytral disc varies from coarse to medium.

Host Trees.—Sitka Spruce and Western White Pine.

Distribution.—Vancouver island and the coast region of British Columbia; Kaslo, B.C.; southward into the United States.

Ips emarginatus Lec.; Am. Phil. Soc. Proc., 15: 363, 364, 1876 (*Tomicus*).

A large elongate species; length, 6 mm. to 7 mm.; entirely distinct in the Canadian fauna by the arrangement of the declivital teeth; that of the 5th interspace is wide, compressed, strongly produced, and emarginate at the tip so that it bears two distinct cusps; in some specimens a more or less distinct small tooth is developed between the tooth of the 5th interspace and the strongly produced apical margin. The male has the front more coarsely sculptured than the female, with a small epistomal tubercle.

Host tree.—Western Yellow Pine.

Distribution.—Throughout the yellow pine region of southern British Columbia, extending into the western United States.

Ips longidens Sw.; Can. Ent., 45: 214, 1911.

Very closely allied to *latidens* Lec. but distinguished by the secondary sexual characters, the coarser interstrial punctures, and usually by the more slender pronotum.

Host tree.—Eastern Hemlock.

Distribution.—New York State, Nova Scotia.

Ips latidens Lec.; Am. Ent. Soc. Trans., 5: 72 (*Tomicus*), 1874; *spinifer* Eichh., Rat. Tomic., 53, 499, 1878 (*Tomicus*).

A small slender species of the Western coast; length, 2·7 mm. to 3·5 mm. This species forms with *longidens* an isolated group, separated by the nearly straight sutures of the antennal club, the deeply, closely punctate-striate elytra, the arrangement of the declivital armature, the secondary sexual characters, and the short though acute apical projection of the declivity.

Host tree.—Western White Pine.

Distribution.—The coast region of British Columbia, extending into the United States.

Ips integer Eichh.; Berl. Ent. Zeit., 273, 1869 (*Tomicus*); Rat. Tomic., 226, 1878.

A large, stout species, from 4·5 mm. to 6 mm. in length; with almost the entire front coarsely, closely granulate-punctate and hairy, a shining median space with a longitudinal pair of small epistomal tubercles, the sutures of the antennal club all very strongly angulated; the pronotum distinctly longer than wide, finely closely asperate in front, rather coarsely punctured behind; the elytral striæ usually strongly impressed, with coarse, deep, quadrate punctures, the discal interspaces convex, the first granulate-punctate to the base, the second with an oblique row of granules on the caudal half and an internal row of punctures of the same length, the remaining discal interspaces impunctate on the basal two-thirds; the declivity coarsely punctured; the 2nd and 3rd teeth in the female conical acute, from a common thickened base and connected by a lateral crescentic ridge, the male with the 3rd tooth longer, subcapitate and somewhat curved; the pubescence of the dorsal surface abundant, long, stiff and reddish. A very abundant species in yellow pine of southern British Columbia. Readily distinguished by its large size and the characters given in the key.

Host tree.—Western Yellow Pine, and recorded from Western White Pine in United States.

Distribution.—Throughout the range of yellow pine in the interior of British Columbia, extending south through western United States into Mexico. A secondary enemy, very abundant in slash and dying trees; apparently also a primary enemy under favourable conditions.

Ips plastographus Lec.; Am. Ent. Soc. Trans., 2: 163, 1868 (*Tomicus*); Am. Phil. Soc. Proc., 15: 362, 364, 1876; Hopkins, Proc. Ent. Soc. Wash., VII, 75-76, 1905.

A series in our collection from California agrees with Leconte's type of *plastographus* in the Agassiz Museum. It is doubtfully distinct from *integer*. The length, 4·5 mm.; black, with the elytra dark red, usually smaller and distinctly more slender than *integer;* clothed with rather short, fine, gray pubescence; the pronotum coarsely, sparsely asperate in front, finely, closely punctured behind; the elytral striæ slightly impressed, the strial punctures small and close; the interspaces nearly flat, the 1st granulate and very narrow, the 2nd with a longitudinal row of granules on the caudal half supported by an internal row of punctures extending to the base of the elytra, the remaining discal striæ impunctate on the basal two-thirds, the declivital armature similar to *integer*, but less strongly developed.

Host tree.—Recorded by Hopkins from *Pinus radiata* (Monterey Pine).

Distribution.—Our specimens are from California, some from San Diego county. We have a series from British Columbia yellow pine that is barely distinct from *plastographus* type, but is left at present in *integer*. Probably we have to deal with only one variable species.

Ips perturbatus Eichh.; Berl. Ent. Zeit., 247, 1868 (*Tomicus*); Rat. Tomic., 248, 1878; *Ips hudsonicus* Lec.; Proc. Am. Phil. Soc., 15: 366, 1876 (*Tomicus*).

Length, 4 mm. to 5·5 mm. Distinguished from its allies by the stout form and usually large size; long, erect, abundant pubescence; short and stout pronotum; the punctuation and pubescence of the first two elytral interspaces; the deep, wide and posteriorly widened sutural striæ; the usually convex interspaces, and the stout rather short declivital armature. The male has the third declivital tooth more acutely pointed.

Host tree.—We have taken this species only in White Spruce.

Distribution.—Newfoundland, Quebec, Ontario, and across Canada, extending north of the prairies in Saskatchewan and Alberta to the Peace river, and through northern British Columbia into the Yukon. It apparently follows the northern range of its host tree. Back's "*Bostrichus typographus* Fabr.," taken on the Great Fish River, was probably this species.

An important secondary enemy but apparently at times of primary importance.

Ips avulsus Eichh.; Berl. Ent. Zeit., 402, 1867 (*Tomicus*); Rat. Tomic., 225, 1878.

Length, 2·8 mm. This very small species is apparently limited to the southern portion of the United States. It is distinguished from its allies by the small size, more feebly developed declivital armature, with the last three teeth subequal, the declivity less excavated, more strongly oblique, and the apical margin but slightly produced.

Ips pini Say, Jour. Acad. Nat. Soc. Phil. 5: 257, 1826; ed. Lec. 2: 319 (*Bostrichus*); Leconte, Am. Phil. Soc. Proc. 15: 363, 365, 1876 (*Tomicus*); Eichhoff, Rat. Tom., 252, 1878 (*Tomicus*).

Length, 3·5 mm. to 4·2 mm.; the front convex and coarsely granulate; the pronotum slightly but evidently longer than wide, finely punctured behind, the punctures smaller towards the middle line, finely, closely, acutely, subconcentrically asperate in front, the sides slightly, arcuately narrowed on the basal three-fourths, emarginately narrowed on the cephalic fourth and narrowly rounded in front; the elytral striæ usually slightly or not at all impressed, with the strial punctures small, the sutural striæ usually but little more evident, the declivity with the 2nd and 3rd teeth acute and similar. The *male* has the front more coarsely granulate, and the 3rd declivital tooth longer, stout, and slightly curved. There are frequent variations in nearly all the external characters; the pronotal punctures vary from moderate in size to small, and nearly obsolete on the middle line; the sides are sometimes distinctly angled at the cephalic fourth; the sutural striæ and less often the other discal striæ are sometimes distinctly impressed, and the elytral punctures are sometimes moderately coarse. The majority of the specimens in our very large collection conform to the characters given in the key.

The *egg-tunnels* radiate from a central nuptial chamber, in number from three to six, engraved on the inner bark and deeply on the wood surface; the eggs are placed singly in niches; the larval mines are mainly on the inner bark, usually short and rapidly widened, the pupal cells en-

graving the wood. The young adults cut irregular, winding food tunnels deeply engraving the wood surface.

Host trees.—White Pine, White Spruce, and other pines and spruces of its range.

Distribution.—Eastern Canada, from the Atlantic to northern Saskatchewan, and in Eastern United States. A series from Fort Yukon, Alaska, does not differ specificially, and it will probably be found across northern British Columbia and Alberta.

Economic importance.—Everywhere abundant throughout eastern pine and spruce forests in slashings and dying trees; at times apparently an important primary enemy.

Ips laticollis, n. sp.

Length, 4 mm.; width, 1·6 mm.; very closely allied to and only doubtfully distinct from *pini* Say. The pronotum is almost as wide as long, with the sides parallel for more than three-fourths the length, then rather distinctly sinuate behind the front margin; very coarsely asperate in front, moderately punctured behind, very densely on the sides; the elytral striæ usually impressed, the sutural striæ more strongly impressed and widened behind, through the second interspace being strongly punctured on the mesal side of the caudal half; the first two sutures of the antennal club rather strongly bisinuate.

The type series was taken near Ottawa, Ont. Type No. 110.

Ips interpunctus Eichh.; Eichhoff, Rat. Tom., 241, 1878 (*Tomicus*): *Tomicus tridens* Eichh., Berl. Ent. Zeit., 274, 1868.

Length, 4 mm. to 5 mm.; the head convex and coarsely granulate; the pronotum as long as wide (sometimes slightly longer), usually rather coarsely and deeply punctured behind, the elytra usually rather deeply striate on the disc, with the interspaces narrow and distinctly convex; the 2nd interspace punctured on the caudal half making the sutural striæ widened behind.

The Jasper race, from Jasper Park region, have the elytral striæ more often lightly impressed, except the sutural striæ, which are almost invariably wide and deep, and the interspaces more often nearly flat.

In pine and spruce of southern British Columbia the typical *interpunctus* is less common and is intergraded with the *oregoni* type. The two forms are there taken in the same trees and *apparently* from the same tunnels. Breeding experiments and biological studies should determine the relationships between these series. Our very large collection from many parts of British Columbia, Alberta, the Yukon, and a smaller collection from the Western States, indicates that *interpunctus* is typically a northern form, tending strongly to vary in Alberta and *apparently crossed* with *oregoni* in southern British Columbia.

Host trees.—Engelmann's Spruce, White Spruce, (Sitka Spruce).

PLATE 27.

INNER FACE OF THE BARK OF A BEETLE-INFESTED WESTERN YELLOW PINE; Almost Three-Fourths Natural Size (Author's illustration).

1, Egg-tunnels of *Dendroctonus valens* Lec.
2, Work of the larvæ of *D. valens* Lec.
3, Egg-tunnels of *Dendroctonus brevicomis* Lec.

PLATE No. 27.

Distribution.—Alaska, the Yukon, British Columbia, and northern and western Alberta; extending into the Western States.

Economic importance.—Usually secondary, but at times evidently a primary enemy.

Ips oregoni Eichh.; Berl. Ent. Zeit., 274, 1868; Rat. Tomic. 150, 1878.

Rather larger and stouter than the typical *pini;* length usually about 4·5 mm.; the pronotum as wide as long with the sides straight and parallel, broadly rounded in front, finely punctured behind; the elytral striæ hardly impressed, the second interspace with a row of punctures on the caudal half making the sutural striæ evidently widened behind; the sides of the elytra rather coarsely punctured. Secondary sexual characters as in *pini* Say. There are variations in southern British Columbia that intergrade with *interpunctus,* and others that can hardly be distinguished from *pini* Say.

Host tree.—Western Yellow Pine.

Distribution.—In British Columbia probably throughout the range of its host; Western United States.

Economic importance.—Usually a secondary enemy in British Columbia, in slashings and weakened trees, but evidently at times an important primary enemy.

The type of *Ips rectus* Lec., Proc. Am. Phil. Soc., 15: 363, 365, 1876, is probably an abraded specimen of *Ips oregoni* Eichh. A similar individual condition is commonly found in species of the genus.

Ips perroti Sw.; Can. Ent., 47: 356, 1915, 2 figs.

Length, 4 mm.; the declivital teeth of the male larger than in the female, the 3rd stoutest and capitate. This species differs from *tridens, borealis* and *interruptus* by the characters of the front, which lie between the much sparser granulation of one sex of *borealis* and the extremely dense granulation of *interruptus;* from *borealis* in the longer, much more finely punctured pronotum, more sparsely punctured elytral interspaces and distinctly much more strongly developed declivital armature; from *interruptus* in the usually much smaller size and more slender form, finer and sparser punctuation, the much more abrupt declivity with strongly marked sexual variation, and the fewer and smaller granules on the first and second interspaces.

Host tree.—Red Pine.

Distribution.—Isle Perrot, Que. Rare.

Ips borealis Swaine; Can. Ent., 45: 213, 1911.

Length, 3·25 mm. to 4 mm.; more slender than *interruptus;* the female with the front and vertex of the head convex, remarkably smooth and polished, with a few *extremely minute* punctures, the anterior portion of the front and the region about the eyes *extremely minutely,* more closely punctured and bearing *minute inconspicuous* hairs; with a very faint, broad, transverse impression between the eyes; the epistoma faintly depressed; the first two sutures of the antennal club broadly bisinuate, the second more strongly; the pronotum with the caudal half shining, coarsely, deeply, roughly, rather sparsely and irregularly punctured; the elytral striæ faintly impressed, excepting the sutural striæ which are wide, deep and broader behind; the strial punctures on the disc round, deep, moderate in size, not close; the declivity with four teeth on each side, of the *pini* type, the third tooth

but little longer than the second, more cylindric, blunt and incurved; the *male* with the front *minutely* granulate-punctate and hairy, rather closely in front of the eyes, with a very small median tubercle, the granules and punctures usually separated with the background distinct. This is vastly different from *interruptus*, with the front very densely and much more coarsely granulate and hairy, or from *dubius* in which the frontal granules are much coarser than in *interruptus* and isolated. There is considerable variation in the size of the punctures of pronotum and elytra, and in some the elytral striæ are distinctly impressed.

Host trees.—White Spruce, Red Spruce, Engelmann's Spruce; doubtfully recorded from Balsam Fir and Eastern Hemlock.

Distribution.—Newfoundland, Nova Scotia, through the northern forests across Manitoba, Saskatchewan, and Alberta, and in the Rocky mountains of Alberta and British Columbia.

It is known to me only as a secondary enemy.

Ips interruptus Mannh.; Bull. Mosc., 357, 1852; 234, 1853 (*Bostrichus*); Eichhoff, Rat. Tomic., 238, 1878.

The original description and Leconte's notes are very meagre. There are probably four species in the Leconte collection under this name. The first was probably received from Mannerheim, and fixes the species.

The length varies from 4 to 5 mm.; the head has the front rather coarsely punctured above, very *densely, finely granulate* and closely hairy on the cephalic half, the granulate portion strongly convex, a transverse impression behind the epistoma, succeeded by a small median fovea; the pronotum slightly longer than wide, rather coarsely and sparsely asperate in front, usually coarsely not closely punctured behind; the elytral striæ slightly impressed, the sutural striæ wide and deep, regularly widened behind, the strial punctures moderate in size and closely placed; the discal interspaces moderately convex, rather finely and uniseriately punctured; the declivital armature of the male *pini* type, with the third tooth stouter than the second and blunt in the female; the male has the third tooth coarser and capitate, and the front a little more coarsely granulate.

Host trees.—Sitka Spruce, Western White Pine.

Distribution.—Alaska and the Pacific Coast region of British Columbia.

Ips hunteri Sw.; Dom. Ent. Br., Dept. Agric., Bull. 14: 31, 1917.

Very closely allied to *I. interruptus* Mannh. in size and sculpture, from which it differs most noticeably by the regularly impressed elytral striæ, the feebly granulate first and second elytral interspaces, and the confused punctures of the alternate interspaces on the elytra.

The front of the head is convex, opaque, densely granulate, with fine and coarser granules intermixed, and closely hairy; the club with the first two sutures bisinuate; the pronotum about as wide as long, narrowly rounded in front, slightly wider at hind angles (this character variable); rather finely and densely asperate in front, moderately, not closely punctured behind, more closely and coarsely on the sides; the elytral striæ narrow, regularly, distinctly impressed, the sutural striæ deeper; the strial punctures small and close; the interspaces finely, uniseriately punctured in front, decidedly confused and feebly granulate near the declivity, the punctures of interspaces 1 and 2 feebly granulate behind but hardly so on the basal half; the declivity coarsely punctured, not closely, with four spines, the third stout, capitate and acute in the male, more slender and less distinctly capitate in the female.

Described from a series of about 180 specimens collected by Prof. S. J. Hunter, at Creede, Colo., 8,844 ft.

Ips dubius, n. sp.

This species agrees closely with *tridens* and *engelmanni* in the characters of the pronotum and elytra, although the punctures are usually rather smaller and the striæ less impressed; the front of the head is entirely distinct, evenly convex and *coarsely, sparsely* granulate, the epistoma slightly, transversely impressed, the median line smooth towards the vertex, less roughened than the sides, and shining cephalad to the epistomal impression. It is to be separated from *interruptus* by the same character and by the sparser elytral punctures; in *interruptus* the front is usually very *densely, finely* granulate, and the elytral punctures small and close. Ten specimens were dissected, representing variations; all were males. The forms here discussed as *tridens, engelmanni* and *dubius* are taken in the same sticks and even together in the same tunnels. This may be due, as is indicated elsewhere, to the wandering of the late-feeding young adults, or it may be that *dubius* is the male of *engelmanni,* or less probably of *tridens. I. pilifrons* Sw. is closely allied to *engelmanni,* and has a somewhat similar frontal structure; the form taken with *pilifrons* and described by the writer as probably the male, differs from *pilifrons* exactly as *dubius* does from *engelmanni.* Biologic studies must be depended upon to determine the relations between these forms. For the sake of convenience *dubius* is given a name; the other form may be referred to as *pilifrons* ♂ until its status is settled.

Type.—A male; Rogers Pass, B.C.; *Picea engelmanni;* 28-IX-15; J.M.S., 2254. Type No. 111.

Host trees.—Engelmann's Spruce, and possibly also White Spruce.

Distribution.—Known to us from the Selkirks and Rockies between Glacier, B.C., and Banff, Alta.

Ips pilifrons Sw.; Can. Ent., 46: 353, 1912.

Abundantly distinct by the characters given in the key. The form described as probably the male was taken with the type, but may be the male of another species; it differs only in having the front convex and coarsely, densely granulate and moderately thickly clothed with long, yellow hairs. Our specimens are mostly from the Cornell University collection and are all from Colorado.

Ips tridens Mannh.; Bull. Mosc., 357, 1852 (*Bostrichus*).

The length varies from 3·8 mm. to 4·8 mm.; with the upper part of the front convex, shining, coarsely and deeply but not densely punctured, with a wide, minutely punctured, transverse impression between the eyes, the region between this impression and the epistomal margin occupied by an enormous, transverse, elevated, subacute, finely granulate, nearly glabrous mass, concave behind, oblique, impressed along the middle line, flattened and minutely pubescent in front; the pronotum with the sides moderately, arcuately narrowed on the sides, rather strongly narrowed in front of the middle and narrowly rounded in front; moderately, deeply punctured behind; the elytral striæ usually distinctly though variably impressed, with the strial punctures round, of medium size and deep, the declivity of the male *pini* type, but with the third tooth rather small and usually hardly capitate. The race in the Selkirks and Rockies has the pronotum usually rather coarsely and closely punctured behind. A series from the Yoho Valley, B.C., has the frontal elevation of the same shape but somewhat smaller. Leconte's type is probably a Mannerheim specimen.

Host trees.—Engelmann's Spruce, Sitka Spruce, and probably White Spruce.

Distribution.—Alaska; Inverness, B.C.; the Selkirks and Rockies of central British Columbia between Glacier, B.C., and Banff, Alta.

Ips englemanni Sw.; Dom. Ent. Br., Dept. Agric., Bull. 14: 30, 1917.

This species agrees with *tridens* in all characters of the pronotum and elytra; it differs only in the nature of the frontal tumulus, which is much less elevated, with its cephalic face densely clothed with very *long, incurved,* light yellow hairs. *Ips pilifrons* Sw. is entirely distinct from *engelmanni* in its larger size, with the strial punctures very coarse, close and usually quadrate, the frontal tumulus still less elevated, with its cephalic face more oblique, longer, and clothed with extremely dense, short, orange to brownish hairs, resembling the pile on velvet. *Engelmanni* has variations in punctuation, depth of striæ and in the stoutness of the third declivital tooth. Ten specimens were dissected, representing all variations, but all were females. The male is thus far unknown. This species is found in the same sticks with *tridens,* and probably through the wandering of the autumn-feeding adults, even in the same tunnels during the winter.

The egg-tunnels were not distinguished from those of *tridens.*

Host trees.—Picea engelmanni, and probably also *P. canadensis.*

Distribution.—Known to us from the Selkirks and Rockies of central British Columbia and from Alberta.

Ips yohoensis Sw.; Dom. Ent. Br., Dept. Agric., Bull. 14: 31, 1917.

A species with the pronotal and elytral characters of *tridens* Mannh., but distinct by the characters of the front. The front is very finely and very densely granulate and finely pubescent on the cephalic half; slightly but distinctly transversely elevated behind the epistoma, which is broadly triangularly impressed medially, immediately in front of the elevation; the epistomal margin and the median impression bearing long yellow hairs; the elevation more evidently pubescent than the remainder of the granulate part of the front, with a trace of a smooth median line. The punctuation of the pronotum is usually coarse and close; the elytral striæ are usually deeply impressed and coarsely punctured with sparser interstrial punctures nearly as large as those of the striæ. The male has the front somewhat more strongly granulate and the third declivital tooth usually somewhat longer and more evidently capitate.

Variations in the size of the punctures are found and also in the depth of the striæ. The median line on the front is in some individuals smooth, shining, sulcate from the epistomal impression to the vertex, and guarded on each side by a small tubercle at the summit of the epistomal elevation. A considerable number of our specimens have the front entirely or almost entirely free from pubescence. They were taken from the same sticks as the typical series and are probably abraded.

Host trees.—Picea engelmanni and probably *P. canadensis.*

Distribution.—Known to us only from the Yoho valley, British Columbia.

PLATE 28.

Dendroctonus pseudotsugæ Hopk.; Tunnels on the inner face of the bark of Douglas fir; one-half natural size (Author's illustration).

PLATE No. 28.

The Genus **Orthotomicus** Ferrari.

Ferrari, Borkenkäfer, 44, 1867.

Neotomicus Fuchs.

Fuchs, Morph. Stud. u. Borkenk., 38, 1911.

Key to the Species.

A The apical margin of the declivity acute, entire, and well defined; the 2nd visible segment of abdomen much shorter than the 3rd and 4th together; the prosternal process elongate and very acute; larger and moderately stout species, the length usually over 2·5 mm.

B The elytral striæ rather strongly impressed; the strial punctures rather coarse and very close; the interstrial punctures deep and uniseriate, nearly as large and numerous as those of the striæ on the caudal half of the disc, making the interspaces rough; the face of the declivity coarsely punctured. **cælatus** Eichh. Page 121.

BB The elytral striæ feebly impressed.

C The strial punctures coarse and not very close, the interstrial punctures nearly as large and close as those of the striæ. **punctipennis** Lec. Page 122.

CC The strial punctures rather small and only moderately close; the interstrial punctures very small on the disc, becoming more numerous and nearly as large as those of the striæ near the declivital margin; the discal interspaces rather smooth and shining; the declivital face finely punctured. **vicinus** Lec. Page 122.

AA The apical margin of the declivity rather ill-defined towards the suture and very narrowly separated from the elytral apical margin; the 2nd visible segment of the abdomen as long as the 3rd and 4th together; small species, slender, usually less than 2·5 mm. in length.

B The front densely granulate; the pronotum elongate, with the sides parallel far beyond the middle and finely punctured behind; the elytra finely regularly striate, the strial punctures very close and moderate in size, the interstrial punctures small, larger and granulate towards the declivity; the declivity decidedly concave, strongly punctured, coarsely toothed, the 2nd and 3rd teeth very coarse in the male. **ornatus** Sw. Page 122.

BB The front coarsely punctured; the pronotum arcuate on the sides, rather coarsely, densely punctured behind; the elytra not striate, the strial and interstrial punctures very small and not close, the interstrial nearly as numerous and as large as the strial and hardly larger or granulate behind; the declivity broadly sulcate, very feebly punctured, feebly toothed, very feebly in the female. **lasiocarpi** Sw. Page 123.

Orthotomicus cælatus Eichh.; Berl. Ent. Zeit., 402, 1867 (*Tomicus*); Rat. Tom. 274, 370, 1878; Zimmerman, Am. Ent. Soc. Trans., 2: 146, 1868 (*Xyleborus*): *xylographus* Fitch, Nox. Ins. N.Y., 4th Rept. 716, 1858 (*Tomicus*).

Length, 2·3 mm. to 3·4 mm., usually about 3 mm. The declivity of the male is distinctly concave, with three teeth on each side, the 2nd and 3rd coarse, slightly within the margin; that of the female is less concave, less distinctly margined, with the teeth smaller, (Pl. 13, fig, 3).

Host trees.—Eastern Spruces and Pines, Eastern Larch.
Distribution.—Eastern Canada and Eastern United States.

Usually an important secondary enemy, working in the thicker bark at the base of the trunk.

Orthotomicus decretus Eichh., Berl. Ent. Zeit., 402, 1867 (*Tomicus*), is stated by Eichhoff to be distinct from *caelatus*. It is apparently not represented in our collections. Eichhoff says, Rat. Tom., 272, 1878:—

" Leconte has united this insect (Syn. Scol. p. 177) with *T. caelatus*. The tubercles of the posterior declivity, however, are arranged in one straight line, so that, looking from above and in front, they are seen to be placed on the continuation of the first interspace, and not on the second interspace as in *caelatus*. The depth of the excavation in the female is, just as in the other species, subplanate, the second and third teeth not near the circumference but situated nearly midway between the margin and the suture."

Orthotomicus vicinus Lec.; Am. Ent. Soc. Trans., 5: 72, 1874 (*Xyleborus*).

Under this name there are four specimens in the Leconte collection labelled " 985," " B. Col." The same species is represented in our collection by long series from northern Alberta and Manitoba, and also by one specimen from Colorado. It has been submerged under *caelatus* Eichh. The pronotum is rather finely and not very densely, punctured behind; the elytral striæ only faintly impressed and less well defined, the elytral punctures usually small, and less numerous than in *caelatus;* the interspaces flat; the declivity sparsely finely punctured and shining; the male declivity with the 2nd and 3rd teeth usually distinctly farther from the margin than in *caelatus;* the female declivity more strongly convex on the sides, with the 2nd and 3rd teeth distinctly nearer the suture than in *caelatus*, the 2nd tooth closer to the suture than to the margin.

This species is doubtfully distinct from *caelatus* Eichh. The great majority of our specimens from the region west of the Great Lakes are distinctly of the *vicinus* type, while the eastern specimens are almost invariably of the true *caelatus* type. The true *caelatus* is also represented from Alaska.

Host trees.—Spruce, Larch.
Distribution.—Manitoba to the Rocky mountains in Canada; described from British Columbia, but not represented from there in our collection; Colorado.

Orthotomicus punctipennis Lec.; Am. Phil. Soc. Proc., 17: 624, 666, 1878 (*Xyleborus*); Eichhoff and Schwarz, U.S. Nat. Mus. Proc., 18: 609, 610, 1896 (*Pityogenes*).

The length, 2·5 mm.; known to me only from the description and the type. The front of the head is entirely retracted in the type. The declivity is much as in the female of *Pityokteines sparsus* (*balsameus*), but more acutely margined and more densely, coarsely punctured. The antennal club is slightly longer than wide, rather thick at the base, and truncate distally as in *caelatus* Eichh.

Orthotomicus ornatus Sw. Can. Ent. 48: 185, 1916.

The length, 2·3 mm., decidedly slender; allied to the typical *Orthotomicus* in the normal front of the female, and in the fairly distinct and complete apical margin of the declivity, but rather closely to the typical *Pityokteines* in the small size, the long second abdominal sternite and the characters of the antennal club.

Host trees.—Western Yellow Pine, Jeffrey's Pine.
Distribution.—Williams, Arizona; Whitman, Oregon; Tulare county, California; possibly extending northward into British Columbia.

Orthotomicus lasiocarpi Sw. Can. Ent. 48: 183, 1916.

The length, 2 mm.; slender. This species is allied to the typical *Pityokteines* in the small size, the long second abdominal sternite and the characters of the male genitalia; but is definitely related to the typical *Orthotomicus* in the distinctly, though very obtusely, margined apex of the declivity and the normal front of the female. The antennal club approaches the condition found in *Pityogenes;* it is flattened, with the upper face obliquely truncate on the distal half, the sutures visible only on the distal half and slightly procurved, the outer segments showing distinctly from below.

Host tree.—Alpine Fir.

Distribution.—Rogers Pass, British Columbia. Taken in recently felled trees with the foliage still green.

The Genus **Pityokteines** Fuchs.

Fuchs, Morph. Stud. u. Borkenk., 37, 1911.

Key to the Species.

A Moderately stout species, with the pronotum very little longer than wide and rather sparsely punctured behind; the interspaces of the elytra rather sparsely punctured on the disc, the declivital teeth moderate in the females and very coarse in the males (Pl. 15, figs. 5, 6.

B The elytral striæ hardly at all impressed, except the sutural striæ, and the strial punctures not very closely placed; the interstrial punctures of the disc as large as those of the striæ (Pl. 16, fig. 3).
sparsus Lec. (*balsameus* Lec.). Page 123.

BB The elytral striæ finely, regularly impressed on the disc; the strial punctures very closely placed; the interstrial punctures smaller than those of the striæ. **elegans** Sw. Page 124.

AA Slender species, with the pronotum decidedly longer than wide, and rather closely punctured behind, the interspaces of the elytra rather closely punctured on the disc, the declivital teeth small in the males and minute in the females.

B The elytra elongate, with the interstrial punctures much smaller than those of the striæ; the female declivity rounded behind as viewed from above, sulcate along the suture, densely deeply punctured, the teeth almost obsolete, represented by extremely minute granules; the male declivity moderately concave, with distinct but poorly developed teeth. **minutus** Sw. Page 124.

BB The elytra with the strial punctures nearly as large as those of the striæ; the declivity broadly rounded behind; the teeth of the female declivity very small but distinct, the male declivity concave, with the 2nd and 3rd teeth rather strongly developed and recurved.
jasperi Sw. Page 124.

Pityokteines sparsus Lec.; Am. Ent. Soc. Trans., 2: 160, 1868 (*Xyleborus*); *balsameus* Lec., Am. Phil. Soc. Proc. 17: 625, 1878 (*Tomicus*).

Length, 2·3 mm. The female has the front of the head flattened, finely carinate, densely punctured and both this area the apical margin of the pronotum densely clothed with very long, incurved yellow hairs, and the elytral declivity deeply sulcate, with three small teeth on each side. The male has the front plano-convex, rather closely granulate-punctate, carinate, lacking the long hairs of the front and apical pronotal margin; with the teeth of the concave declivity much larger, the 2nd pair largest and incurved (Pl. 15, figs. 5, 6).

Host trees.—Balsam Fir, Eastern Larch.

Distribution.—Eastern Canada and Eastern United States, probably throughout the range of the eastern balsam.

An important primary enemy of balsam fir.

Pityokteines elegans Sw.; Can. Ent., 48: 182, 1916.

Length, 2·5 mm. This species is known to us only from Hood river, Oregon, and Hayfork, Cal., but possibly extends into British Columbia. It probably breeds in one of the western balsams, with habits similar to those of *sparsus* Lec., to which it is closely allied.

Pityokteines minutus Sw.; Can. Ent., 44: 352, 1912 (*Dryocœtes*).

Length, 1·7 mm. to 2·3 mm. This species was described from the female; owing to the almost complete absence of even granules on the type it was placed erroneously in the genus *Dryocoetes*. The type is from Colorado; the host tree unknown.

Pityokteines jasperi Sw.; Can. Ent., 48: 181, 1916.

Length, 2·3 mm.; very slender; the female with the front plano-convex, densely finely granulate and densely hairy as in *minutus;* the front of the male plano-convex, densely, deeply granulate-punctate and sparsely hairy. The elytra are slightly but constantly shorter than the type of *minutus* Sw. Recent collections indicate that *jasperi* is only doubtfully distinct from *minutus*.

Host trees.—Mountain Balsam (Alberta); Douglas Fir (Oregon).

Distribution.—Jasper Park, Alberta; probably extending southward in the Canadian Rockies; Oregon.

The Genus **Anisandrus** Ferrari.

Ferrari, Borkenkäfer, 24, 1867.

Key to the Canadian Species.

A The body stout, cylindric, with the hind wings well developed. The pronotum asperate in front, nearly smooth behind; the 2nd and 3rd interspaces of the declivity without teeth. Females (Pl. 11, fig. 2).

B The elytra with the sides strongly angled behind as viewed from above, and the apex subacute (Pl. 18, fig. 16).

C The declivital ridge of the 7th interspace with a few elongate teeth intermixed with granules; a much larger species, length, 3·3 mm. to 3·7 mm. (Pl. 18, fig. 16). **obesus** Lec. Page 125.

CC The declivital ridge with granules only; the form more slender, a smaller species; length, 3 mm. to 3·2 mm. **populi** Sw. Page 126.

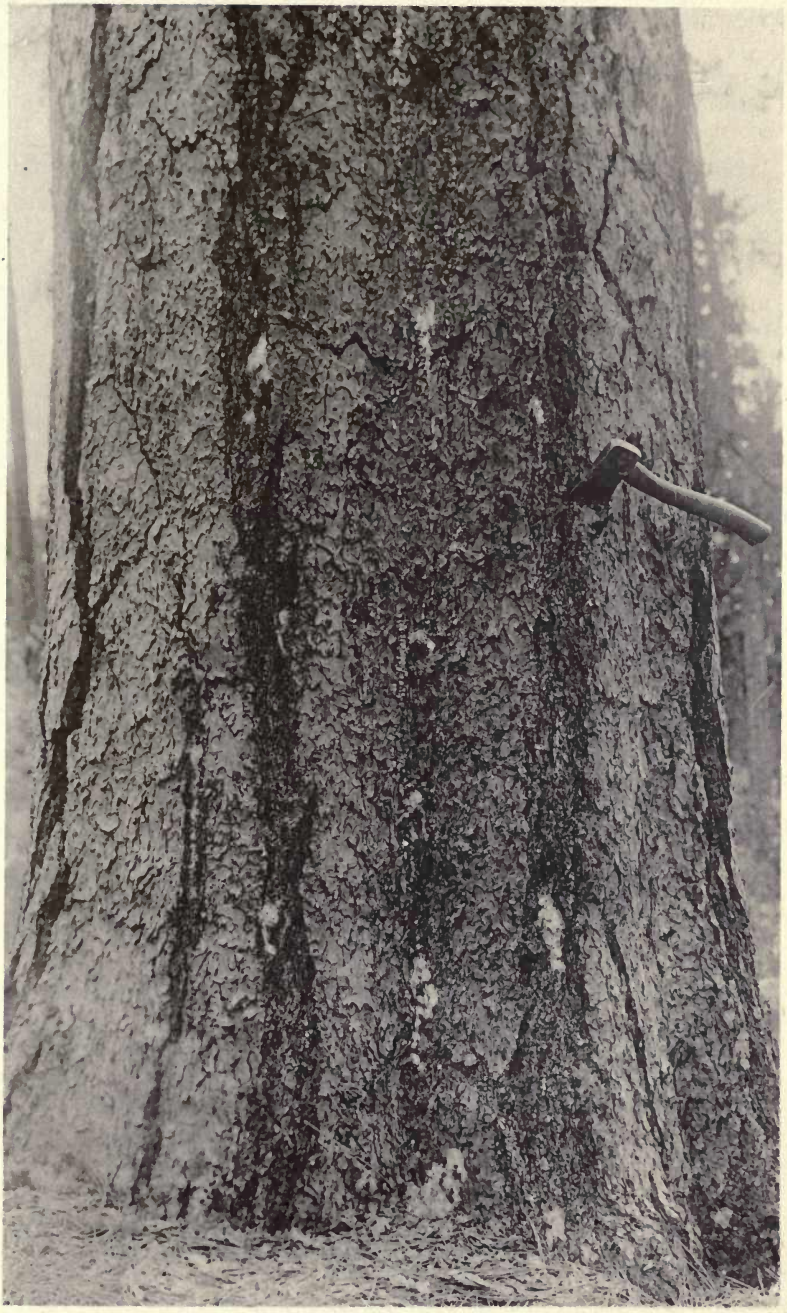
BB The elytra with the sides behind and the caudal margin evenly arcuate.

C A larger species; length, 3 mm. to 3·25 mm.; the pronotum as long as wide; the strial punctures of the elytra closely placed, the distance between the punctures equal to or less than their diameter (Pl. 11, fig. 2). **pyri** Peck. Page 125.

PLATE 29.

Dendroctonus brevicomis Lec., The Western Pine Bark-beetle; pitch-tubes on the bark surface of an infested western yellow pine; near Princeton, B.C. (Author's illustration).

PLATE No. 29.



CC Length, 2·35 mm. to 2·5 mm.; the pronotum slightly wider than long as viewed from above; the punctures of the elytral striæ more widely spaced, the distance between the punctures usually greater than their diameter, (Pl. 18, fig. 14).

minor Sw. Page 125.

AA The body much smaller, depressed and curved into the arc of a circle; very strongly convex; oval in outline from above; the wings functionless; the pronotum smooth behind; the declivity without teeth. Males (Pl. 11, fig. 1).

B The pronotum without asperities, at most with minute granules.

C Usually distinctly larger, stouter; the interstrial punctures of the elytra small; with fine punctures on the front of the head.

obesus Lec. Page 125.

CC Usually distinctly smaller and more slender; length, 1·6 mm.; the interstrial punctures of the elytra nearly as coarse as those of the striæ; with coarse, sparse punctures on the front of the head.

populi Sw. Page 126.

BB The pronotum with the cephalic half asperate or distinctly coarsely granulate.

C The pronotum narrowed in front, rather closely asperate; the disc of pronotum and elytra nearly glabrous. **pyri** Peck. Page 125.

CC The pronotum subcircular, coarsely granulate in front; the disc of pronotum and elytra hairy; very much smaller.

minor Sw. Page 125.

Anisandrus obesus Lec.; Am. Ent. Soc. Trans., 2: 159, 1868 (*Xyleborus*); *serratus* Sw., Can. Ent., 42: 162, 1911.

Female.—Length, 3·3 mm. to 3·7 mm., stout, black when mature, sparsely clothed with long slender, gray hairs; allied to *pyri* but distinctly stouter, with the acute ridge of the seventh declivital interspace sparsely, strongly serrate. *Male:* length, 1·65 mm. to 1·75 mm; dark brown when mature, smaller and more fragile than the male of *dispar* (Pl. 18, fig. 16).

Host trees.—Birches, Oaks, Maples, Beech.

Distribution.—Southern Ontario, southern Quebec, Eastern United States.

Anisandrus pyri Peck; Mass. Agric. Jour., 4: 205-7, 1817 (*Scolytus*).

Length, female, 3 mm. to 3·25 mm.; male, 2 mm. to 2·2 mm. Doubtfully distinct from the European *dispar* Fabr. There appears to be no satisfactory specific difference between our Canadian species and the short series of both sexes of *dispar* from Europe in our collection (Pl. 18, fig. 13).

Host tree.—Apple.

Distribution.—Nova Scotia, southern Ontario, Eastern United States.

Anisandrus minor Sw. Can. Ent., 44: 164, 1910.

The female, length, 2·25 mm. to 2·5 mm.; the male, length, 1 mm. to 1·2 mm. An examination of the type of *obesus* Lec. confirms Hopkins' statement that *minor* is a distinct species.

Host trees.—Maples, Beech.

Distribution.—Southern Ontario, southern Quebec, and Eastern United States. In dying trees.

Anisandrus populi Sw. Dom. Ent. Br., Dept. Agric., Bull. 14: 22, 1917.

Host trees.—Poplars.

Distribution.—Ste. Anne de Bellevue; Chelsea, Que.; probably well distributed through southern Quebec and southern Ontario. Abundant locally in unthrifty and dying trees, with *T. retusus* Lec. (Pl. 18, fig. 15.)

The Genus **Xyleborus** Eichhoff.

Eichhoff, Berl. Ent. Zeit., p. 37, 45, 46, 1864.

Key to the Species, based on Females.

A The scutellum indistinct, oblique, carinate, and depressed (*Xyleborinus* Reitter). The apex of the elytra very broadly rounded, with a prominent acute marginal granule on each side the apex, at the end of the 3rd interspace; the elytra strongly narrowed on the caudal half, rather closely serrate on the 1st and 3rd interspaces, with about six well-developed acute points on each, the 2nd interspace slightly impressed; the declivity subopaque. **saxesceni** Ratz. Page 127.

AA The scutellum distinct, horizontal, smooth, not depressed. The apex of the elytra rather narrowly rounded, without a distinct marginal granule at the end of the 3rd interspace; the sides parallel beyond the middle of the elytra, only moderately narrowed behind, the declivital granules sparser, usually three or four on the declivital face.

B Declivity of the elytra with the 1st interspace granulate or finely tuberculate.

C Elytral declivity flattened.

D Rather elongate; the pronotum decidedly longer than wide; the elytra evidently narrowed behind with the apical margin rather narrowly rounded; the flattened area of the declivital face narrower, hardly including the 4th interspace, the declivity usually strongly opaque.

The Harris metatype of **xylographus** Say. Page 127.

DD Moderately stout; the pronotum slightly longer than wide; the elytra only very faintly narrowed just before the declivity, the apical margin broadly rounded; the flattened area of the declivity wider, including the 4th interspace; the declivity semi-opaque. **canadensis** Sw.* Page 127.

CC Elytral declivity evidently convex as seen from above, shining; strial punctures of the declivity very coarse and shallow; the 1st and 3rd interspaces with about four very small, widely separated granules; the pronotum roughly punctured behind; the elytral striæ strongly impressed and the interspaces convex. **pubescens** Zimm. Page 128.

BB Declivity of the elytra with the first interspace unarmed except at the summit.

C Declivity with the 2nd interspace bearing two large subequal teeth, the four at the angles of a square; the 3rd unarmed; the 4th and outer interspaces with acute granulations; the declivity flat, obliquely truncate, with the margin acute and serrate on the sides below; size much larger, 4 mm.–4·5 mm. **celsus** Eichh. Page 128.

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* *propinquus* Eichh. has the pronotum lightly punctured behind, the elytral striae faintly impressed and the declivity subopaque. Not known from Canada.

CC Declivity with the 3rd interspace tuberculate, 2nd unarmed except at top of declivity, length less than 4 mm.

D Punctures of pronotum rather sparse, variable in size, mostly fine; declivity with one well developed, acute spine near middle of 3rd interspace, with a second nearly or quite obsolete below, the 2nd interspace nearly flat.

fuscatus Eichh. Page 128.

DD Punctures of pronotum close, variable in size, rather coarser than *fuscatus;* declivity with three acute spines on 3rd interspace, the 2nd largest, the 1st well developed, and the 3rd smaller to nearly obsolete; the 2nd interspace sulcate.

impressus Eichh. Page 128.

Xyleborus saxesceni Ratz.; Forstins. 1: 167, 1837 (*Bostrichus*).

Length, 2·5 mm., slender.

A species that is apparently identical in every way with our European specimens of *saxesceni* Ratz. is represented in our collection from New York State, Michigan and Indiana. It is not known to occur in Canada. (*Xyleborinus* Reitter).

X. Arbuti Hopk. is distinguished from *saxesceni* by the shining declivity, the length 2·4 mm., striæ 1 and 2 impressed, punctures distinct, declivity subconvex, shining, interspaces 1 and 2 elevated. Walker, Cal., in *Arbutus menziesii.* This species may occur in the same host in British Columbia.

Xyleborus xylographus Say.; Acad. Nat. Phil., Jour 5: 256; ed, Sec. 2: 318.

So far as we can learn the type is not in existence and has apparently not been seen since the time of Dr. Harris. There is a single metatype in the Harris collection at Boston, labelled, "744, N.C.", "*Tomicus xylographus* Say 744, teste Say." This specimen should apparently be accepted as fixing the species.

Length, 2·7 mm., rather slender, the pronotum rather strongly and closely punctured behind, the punctures of varying size, the elytral striæ slightly impressed, strial punctures moderate, interstrial punctures smaller, uniseriate, punctures distinct on the sides; declivity flattened, decidedly opaque, the suture wide and slightly elevated, with about three widely separated, small acute granules, the 2nd interspace flat, hardly impressed, with small granules above the face of the declivity; the 3rd interspace slightly elevated and granulate as upon the first. Would fall under "*inermis* Eichh." in Hopkins' key to *Xyleborus.*

Host trees.—Probably various hard wood species.

Distribution.—New York state from Buffalo to New York City; New Jersey; Wisconsin; Washington, D.C.; North Carolina; Virginia and Missouri. Not known to occur in Canada.

Xyleborus inermis Eichh. is very closely allied to and possibly identical with *xylographus* Say. The lateral interspaces of *inermis* are described by Eichhoff as "sparsely, lightly punctured."

Xyleborus affinis Eichh. has the pronotum very lightly and sparsely punctured behind, and is apparently distinct thereby. I have not recognized either *inermis* or *affinis* from Canada or the Northern States.

Xyleborus canadensis Sw.; Dom. Ent. Br., Dept. Agric., Bull. 14, 24, 1917.

Length, 2·6 mm.; moderately stout, differs from *xylographus* chiefly in the distinctly stouter form, the sides of the elytra parallel far beyond the middle, hardly narrowed before the declivity, rather broadly rounded

behind, broadly flattened on the declivity, the striæ only very faintly impressed.

Host tree.—Oak stump, species not determined.

Distribution.—Isle Perrot, Que., 29–VIII–1910. Apparently very rare.

Xyleborus pubescens Zimm.; Am. Ent. Soc. Trans., 2: 145, 1868.

Length, 2·7 mm., slender; the pronotum strongly punctured behind, the elytral striæ distinctly impressed; the declivity moderately convex, shining, the striæ impressed, the strial punctures very coarse, shallow, and not very regular, the 1st and 3rd interspaces slightly elevated and armed each with three or four rather coarse, acute granules.

Described from material compared with the type of *pubescens* Zimm. in the Leconte collection. Allied to but distinct from *inermis* Eichh.

This species agrees closely with Eichhoff's description of his *pini*, and probably *pini* Eichh. (1867) should be used instead of *pubescens* Zimm. (1868).

Distribution.—Represented in our collection from Virginia, Florida, and Alabama. It will probably not occur in Canada.

Xyleborus celsus Eichh.; Berl. Ent. Zeit., p. 400, 1867.

Length, 4 mm. to 4·5 mm.; a large and very distinct species. Breeds in hickories in the Eastern and Southern States; it may occur in southern Canada but has not been recorded.

Xyleborus fuscatus Eichh.; Berl. Ent. Zeit., p. 400, 1867.

Length, 3·2 mm., female; 2·1 mm., male. Occurs in the Southern United States, north to New Jersey; recorded from oak and other hardwoods; not known from Canada.

Xyleborus impressus Eichh.; Berl. Ent. Zeit., p. 400, 1867.

Length, 2·7 mm., female. Occurs in the Southern United States, north to Massachusetts; not known from Canada.

The Genus **Xylocleptes** Ferrari.

Ferrari, Borkenkäfer, 37, 1867.

Several species occur in the United States, chiefly in the south and west, usually in *Cucurbita*. None recorded from Canada.

The Genus **Dryocoetes** Eichhoff.

Eichhoff, Berl. Ent. Zeit., 38, 1864.

Key to the Canadian Species.

A The sutural striæ strongly impressed on the disc and declivity, very small species, not much exceeding 2 mm. in length; the strial punctures of the elytra much larger than those of the interspaces.

PLATE 30.

Dendroctonus monticolæ Hopk.; tunnels on the inner face of the bark; from a Western Yellow pine killed by the beetles; about four-fifths natural size (Author's illustration).

1, Egg-tunnels.
2, Larval-mines.
3, 3a, Egg-tunnels of *Ips integer* Eichh.

PLATE No. 30.

B The declivity flat, with the 2nd striæ also distinctly impressed; the form moderately stout, 2·5 times as long as wide, the pronotum as wide as long and strongly convex. British Columbia.
sechelti Sw. Page 130.

BB The declivity convex, the 2nd striæ there hardly impressed; the strial punctures on the declivity as coarse as on the disc; the form more elongate; the pronotum longer than wide. Pennsylvania.
granicollis Lec. Page 130.

AA The sutural striæ not very widely and deeply impressed on either disc or declivity; larger species, usually well over 2 mm. long.

B The ventral surface with coarse, round, shallow punctures; the pronotum widest usually at or near the middle, the interstrial punctures of the elytra much smaller and sparser than those of the striæ; the antennal club with the basal corneous part usually evidently wider than long, the pubescent apical surface projecting beyond the distal margin of the basal corneous part.

C The female with the front only sparsely hairy; the pronotum with the punctures more or less obscured by the asperities on the frontal half, but distinct from the base to considerably beyond the middle, variably but distinctly punctured, and finely granulate to moderately asperate on the sides behind; the declivity convex or rather strongly flattened.

D The declivity evidently flattened, with the 2nd interspace impressed; the odd interspaces of the elytral disc wider and confusedly punctured from the top of the declivity usually to the base, with the strial punctures usually rather small; the pronotum with punctures of varying size, large, usually as wide as the elytra, with the sides frequently nearly parallel on the median third, broadly rounded on the front margin (Pl. 11, fig. 4). **pseudotsugæ** Sw. Page 130.

DD The declivity convex (rarely slightly flattened in *septentrionis*); the elytral interspaces rather regularly and uniseriately punctured (frequently somewhat confused near the declivity in *septentrionis*).

E The pronotum large, usually as wide as the elytra, sides usually subparallel on the median third, feebly rounded behind, a little more strongly in front and broadly rounded on the front margin; the strial punctures of the elytra usually coarse, the striæ evidently impressed on the disc and declivity, and as wide as the rather narrow interspaces, length usually less than 4 mm. Eastern America.
americanus Hopk. Page 131.

EE The pronotum apparently rather small, usually narrower than the elytra, very strongly arcuate on the sides, strongly narrowed behind, more strongly in front, narrowly rounded on the front margin; the strial punctures of the elytra usually rather small, the striæ faintly impressed, the interspaces wide, the length usually more than 4 mm. Northern Alberta to Alaska.
septentrionis Mannh. Page 131.

CC The females with the front densely pubescent with long reddish-yellow hairs; the pronotum with the punctures on the frontal half almost entirely obscured by the asperities, and considerably obscured by the strongly developed asperities on the sides; the

declivity strongly flattened, with the first two striæ impressed (Pl. 11, fig. 5). **betulæ** Hopk. Page 131.

BB The ventral surface finely punctate; the pronotum widest well behind the middle and much more strongly narrowed in front than behind; the interstrial punctures of the elytra at least nearly as coarse and numerous as those of the striæ; the antennal club with the basal corneous part as long as or longer than wide, with the apical pubescent surface only slightly convex, and hardly projecting beyond the distal margin of the basal part.

C The elytral interspaces confusedly punctured on the disc and sides; the frontal hairs of the female straight, rather short, and forming an extremely dense brush almost completely hiding the surface; the interstrial punctures evidently smaller than those of the striæ, particularly on the sides; the size large, length about 4 mm. **confusus** Sw. Page 131.

CC The elytral interspaces rather regularly uniseriately punctured; the interstrial punctures practically as large and numerous as those of the striæ on the disc and sides; the front of the female very closely hairy, but with the hairs long and rather uneven, not in a dense brush, and not concealing the surface at the middle line; length, 3·2 mm. or less.

D The punctures on the declivity as coarse in both sexes as those on the disc. **pubescens** Sw. Page 132.

DD The punctures of the declivital striæ and interspaces much smaller and sparser in the male, and in both sexes distinctly smaller than those of the disc (Pl. 11, fig. 3). **affaber** Mannh. Page 132.

The eastern race has a slightly smaller average size; from Manitoba eastward to the Atlantic coast. **piceæ** Hopk.

Dryocoetes sechelti Sw.; Can. Ent., 47: 358, 1915.

It is known to us only by a series sent from Sechelt, B.C., by the late Tom Wilson.

Dryocoetes granicollis Lec.; Am. Ent. Soc. Trans., 2: 162, 1868 (*Xyleborus*).

It is known to us only by the specimens in the Leconte collection.

Dryocoetes pseudotsugæ Sw.; Can. Ent.; 47: 360, 1915.

The length varies from 3·5 mm. to 4·9 mm., with very few less than 4 mm. The pronotal punctures and asperities are small and dense; the strial punctures of the elytra usually small; the declivity is sometimes less flattened than usual, and the discal interspaces rarely with the punctures confused at the base and towards the declivity only; such variations could easily be mistaken for *septentrionis*. The male has the front very wide, strongly granulate, with a broad, shining, transverse impression; the front of the female is moderately wide, less shining, the declivity less strongly flattened; the front in both sexes is clothed with rather abundant long hairs (Pl. 11, fig. 4).

Host trees.—Douglas Fir. It may occur also in Balsam and Spruce.

Distribution.—Very abundant in the coast region of British Columbia, probably throughout the range of its host tree in that province, southward to Oregon.

Dryocoetes americanus Hopk.; U.S. Dept. of Agric., Office of Secy., Rept. No. 99, p. 51, 1915; previous literature under *autographus* Ratz.

Length, 3 mm. to 4 mm. Doubtfully distinct from *autographus* Ratz. of Europe. Several rather distinct variations could be described. The so-called species of this section of the genus are little more than well marked varieties.

Host trees.—White Spruce, Engelmann's Spruce, White Pine, Larch, and probably all Spruces and Pines within its range.

Distribution.—Eastern North America, west into the Rocky Mountain region.

Dryocoetes septentrionis Mannh.; Bull. Mosc., 298, 1843 (*Bostrichus*); *semicastaneus* Mannh., Bull. Mosc., 358, 1852 (*Bostrichus*).

Length, 3·5 mm. to 4·7 mm., usually over 4 mm. Very closely allied to *americanus*, with which it appears to intergrade, particularly in the Rockies and Northern Alberta; usually distinguished by the smaller pronotum with the sides strongly arcuate, strongly narrowed in front and behind, more strongly in front, and narrowly rounded on the front margin, and by the wide elytral interspaces. The male has the front very wide; the declivity often somewhat flattened and frequently obscurely granulate.

Host trees.—Sitka Spruce, Engelmann's Spruce, White Spruce.

Distribution.—Alaska and the northern coast of British Columbia, eastwards throughout northern Alberta into the eastern spruce forests of Northern Canada; less common in southern British Columbia.

Dryocoetes betulæ Hopk.; U.S. Dept. of Agric., Office of Secy., Rept. 99, p. 50, Redescribed, 1915; *eichhoffi* Hopk., Can. Ent. 26: 279, (name preoccupied).

The female has the front plano-convex, densely granulate-punctate, rather densely clothed with long, erect, yellow hairs, longer about the margin, with a rather distinct median smooth space; the male has the front sparsely granulate-punctate and sparsely clothed with long, erect, yellow hairs, the beak very wide and transversely impressed, with the median line subcarinate. Length, 2·5 mm. to 4·5 mm. (Pl. 11, fig. 5).

Host trees.—Birches, probably all Canadian species.

Distribution.—Our largest collections are from Newfoundland, Quebec, Ontario, and British Columbia. Hopkins and Felt record it from various places in the Eastern States. Throughout Canada and probably throughout the northern United States.

Dryocoetes liquidambaris Hopk.; U.S. Dept. of Agric., Office of Secy., Rept. 99, 51, 1915.

Closely allied to *betulæ*; distinguished by Hopkins as follows:—

"Pronotal punctures limited to median dorsal area. Grant county, West Virginia, in Betula sp. **betulæ** Hopk.

"Pronotal punctures not limited to median dorsal area. Virginia Beach, Va., in *Liquidambar styraciflua.*" **liquidambaris** Hopk.

Host tree.—Liquidambar styraciflua.

Distribution.—Virginia Beach, Virginia, U.S.A.

The species is unknown to us. The host plant is not indigenous to Canada, but the beetle may possibly be found in *Hamamelis.*

Dryocoetes confusus Sw.; Can. Ent., 146: 351, 1912; *abietis* Hopk, U.S. Dept. Agric., Office of Sec., Rept. 99, p. 52, 1915.

Length, 3·4 mm. to 4·2 mm., clothed with erect reddish hairs. The female has the front entirely covered by a circular, very dense brush of short, reddish-yellow hairs, longer about the margin; the declivity has the

first two striæ strongly inpressed, the strial punctures very small, the 1st interspace convex, the 2nd less prominent and flattened apically, the outer part of the declivity strongly convex, the interspaces shining, rather coarsely granulate and setose-punctate uniseriately. The male has the front somewhat wider than the female, plano-convex, densely, coarsely, roughly punctured, with a shallow, transverse, postepistomal impression and a faint median carina in front and behind, sparsely clothed with long hairs; the declivity more polished, the punctures minute and the granules small and sparse on the first two interspaces.

Described from Colorado, and since found to be very abundant in the Canadian Rockies and Selkirks; the Canadian series presents variations but is probably not distinct. Hopkins' *abietis*, described from *Abies* of Montana, is apparently the same species.

Host trees.—Alpine Fir, Eastern Balsam Fir.

Distribution.—Colorado; Montana (*abietis* Hopk.); Rockies and Selkirks of British Columbia, and in northern Alberta.

Attacks and kills healthy balsam in eastern British Columbia and northern Alberta.

Dryocoetes pubescens Sw.; Can. Ent., 44: 350, 1912.

Closely allied to *affaber* Mannh., from which it is doubtfully distinct in the more slender form and densely, coarsely punctured declivity. It will probably prove to be only a well marked race of *affaber*.

Distribution.—Colorado; habits unknown.

Dryocoetes affaber Mannh.; Bull. Mosc., 359, 1852 (*Bostrichus*).

The species of this section of *Dryocoetes* are very closely allied. *D. piceæ* Hopk. was separated from *affaber* through its smaller average size, 2·3 mm. to 2·75 mm., and its eastern distribution. Our specimens from the Maritime Provinces and Quebec are constantly small, less than 2·75 mm. in length, and rather more coarsely punctured than the western specimens; our specimens from Manitoba are very faintly larger, a long series from Edmonton ranging between 2·5 mm. and 3 mm. in length; seventy-five specimens from south central British Columbia vary between 2·6 mm. and 3·1 mm.; over two hundred from northern Alberta range between 2·3 mm. and 3·2 mm., with many 2·8 mm., and our typical *affaber* from the northern coast of British Columbia varies between 2·5 and 3·2 mm. with an average of nearly 3 mm. Our collection indicates a gradual increase in size towards the north and west but presents no definite specific distinction between the typical *affaber* and our eastern race which is apparently *piceæ* Hopk., left in this paper as doubtfully distinct. (Pl. 11, fig. 3).

Host trees.—Sitka Spruce, all spruces and probably all pines within its range.

Distribution.—Alaska, throughout British Columbia and western and northern Alberta, eastward through the northern spruce forests; recorded by Hopkins through the Western United States south to Mexico.

PLATE 31.

Dendroctonus brevicomis Lec., The Western Pine Bark-beetle; egg-tunnels on the wood surface of Western Yellow Pine; near Princeton, B.C. (Author's illustration).

PLATE No. 31.

Dryocoetes caryi Hopk.; U.S. Dept. of Agric., Office of Sec'y, Rept. No. 99, 50, 1915.

"Pronotum with sides nearly straight, and basal angles not rounded."

"Pronotum with posterior area distinctly punctured; antennal club with one faint recurved suture on anterior face and two faint recurved sutures on posterior face." "Length, male type, 2·15 mm.; body oblong, ellipitical, ferruginous; pronotal rugosities fine, densely placed, and changing to rugose punctures to base; front flat, shining, distinctly and evenly punctured, with a few long hairs toward the sides, and with faint median line; declivity steep, subconvex, interspace 1 elevated, 2 and 3 flat, striæ with coarse punctures. Camp Caribou, Maine, in *Picea* sp., May 25, 1900; Austin Cary, collector; Hopk. U.S. No. 332c. Type, Cat. No. 7629, U.S. National Museum."

Female.—"Front flattened, slightly more pubescent than in the male; declivity more opaque and interspace 1 not so strongly elevated."

This species is unknown to us. Since it occurs in Maine it will probably be found in Eastern Canada.

Host tree.—Spruce.

Distribution.—Camp Caribou, Maine.

The Genus **Lymantor** Lövendal.

Ent. Medd., vol. 2, p. 161, 1889.

Lymantor decipiens Lec.; Am. Phil. Soc. Proc., 17: 624 (*Xylocleptes*), 1878.

Length, 1·8 mm.; the front punctured, with a transverse postepistomal impression; the pronotum longer than wide, feebly asperate in front, rather coarsely and deeply punctured behind; the elytra coarsely and deeply, not very closely punctured, not striate, the punctures rather irregular, the rows hardly evident. There is sometimes a fairly distinct fifth segment in the funicle.

Host trees.—Hicoria, Pyrus, Acer (literature). Taken by the writer only in dead and dry maple limbs. The egg-tunnels and larval mines are entirely in the outer wood, sometimes below the surface; both adults and larvæ find an important food in certain black wood fungi, which are always abundant in the limbs they frequent.

Distribution.—Eastern Canada and Eastern United States.

LIST OF CONIFEROUS HOST TREES.

Balsam, Eastern (see Fir, Balsam).
Balsam, Mountain (see Fir, Alpine).
Balsam, Lowland (see Fir, Grand).

†Cedar, Incense. *Libocedrus decurrens* Torrey.
†Cedar, Port Orford (Lawson's Cypress). *Chamæcyparis Lawsoniana* (Murr) (Parlatore).
Cedar, Western Red (Red Cedar). *Thuja plicata* Don.

Fir, Douglas (Douglas Spruce). *Pseudotsuga taxifolia* (Poir) Britt. (*P. mucronata* (Raz.) Sudworth).
Fir, Balsam (Eastern Balsam). *Abies balsamea* (Linn.) Miller.
Fir, Alpine (Mountain Balsam, White Fir, Balsam Fir). *Abies lasiocarpa* (Hook) Nuttall.
Fir, Grand (Lowland Balsam, White Fir). *Abies grandis* Lindley.

Hackmatack (see Larch).
Hemlock, Mountain (Black Hemlock). *Tsuga mertensiana* (Bong) Sargent.
Hemlock, Western. *Tsuga heterophylla* (Raf.) Sargent.
Hemlock, Eastern. *Tsuga canadensis* Engelm.

Larch, Eastern (Tamarack, Hackmatack). *Larix americana* Michx.
Larch, Western. *Larix occidentalis* Nuttall.

Pine, White. *Pinus strobus* L.
Pine, Western White (Silver Pine). *Pinus monticola* Dougl.
†Pine, Sugar. *Pinus lambertiana* Dougl.
Pine, Western Yellow (Bull Pine). *Pinus ponderosa* Lawson.
†Pine, Jeffrey. *Pinus jeffreyi* "Oreg. com."
Pine, Lodgepole (Shore Pine, Black Pine, Jack Pine). *Pinus contorta* Loudon, (*Murrayana*).
†Pine, Monterey. *Pinus radiata* Don.
Pine, Red (Norway Pine). *Pinus resinosa* Ait.
Pine, Jack (Labrador Pine, Gray Pine). *Pinus banksiana* Lamb. (*Pinus divaricata* D. Mont.)
†Pine, Scrub (Jersey Pine). *Pinus virginiana* Mill. (*Pinus inops* Ait.)
†Pine, Southern Yellow. *Pinus taeda* Linn.

Spruce, Sitka (Tideland Spruce). *Picea sitchensis* (Bong.) Trautvetter and Mayer.
†Spruce, Big Cone. *Pseudotsuga macrocarpa* (Torr.) Mayer.
Spruce, Engelmann's. *Picea engelmanni* Engelmann.
Spruce, Red. *Picea rubens* Sarg.
Spruce, White. *Picea canadensis* (Mill) B., S., and P.
Spruce, Black. *Picea mariana* (Mill) B., S., and P.

Tamarack (see Larch).

GLOSSARY.

Abraded: rubbed, denuded of vestiture.
Aciculate: applied to a surface bearing minute subparallel scratches as though made with a needle point.
Acuminate: tapering to an acute point.
Alutaceous: of colour, pale brown; covered with minute cracks.
Anastomosing: running together, applied to surface markings in colour, or minute ridges, and to tunnels.
Annulate: ringed; of a club, sutured.
Apex: the arcuate or narrowed portion of a segment or selerite opposite the basal attachment; of the elytra, the caudal portion; of the pronotum, the cephalic portion; of the antennal club, the distal portion; the portion of an appendage farthest from the body, the distal part.
Appendage: a part attached by a joint to the body or to a larger appendage; e.g., antennæ, legs and wings.
Approximate: placed close together.
Armature: the chitinous teeth, processes, or coarse roughenings.
Asperate: with the surface finely or moderately roughened with acute or subacute elevations.
Asperities: small or moderate surface roughenings, particularly when acute; from coarse granules to rather prominent elevations; especially the lunular elevations of the anterior half of the pronotum in the *Ipinæ*.

†In United States.

Base: the portion of a segment or selerite nearest the middle of the body; of the elytra, the cephalic portion; of the pronotum, the caudal portion; the portion of an appendage nearest the body, of the antennal club the proximal portion.
Beak: the rostrum, a prolongation of the head in front of the eyes bearing the mouth parts at the apex.
Beetle-trees: trees which have been killed or are attacked by bark-beetles.
Bifid: deeply emarginate or split.
Bifurcate: forked.
Bisinuate: with two sinuations or broad double curves.
Bristle: a short, stiff hair.
Brood: the progeny of a single pair of adults developing from the same lot of eggs. The same parent female of the first generation may deposit a second lot of eggs later in the season; the individuals developing therefrom will form a second brood of the first generation.

Callosity: a broadly convex or flattened elevation.
Callus: a small callosity.
Capitate: applied to an antenna with the distal segments swollen to form a subglobular mass.
Carina: a narrow ridge or keel.
Caudad: the direction from the head towards the posterior end of the body along the median line.
Caudal: pertaining to or towards the posterior end of the body.
Cephalad: the direction from the posterior end towards the head along the median line.
Cephalic: pertaining to or towards the head.
Chitin: a horny substance forming the hard portions of the insect's body.
Chitinized: hardened with chitin.
Cinereous: ash-gray in colour.
Clavate: club-shaped.
Club: the distended apical segments of the antenna.
Compressed: flattened from side to side.
Confusedly: irregularly; of punctures and pubescence, not in regular rows.
Connate: applied to segments which have fused into a more or less solid mass.
Constricted: suddenly narrowed and more or less dilated on each side the constriction.
Contiguous: touching when in the normal position.
Convergence: the development of similar characters in species of separate origin often through the effect of similar habits or environment.
Corneous: resembling horn.
Crenulate: applied to a margin forming a waved line with small, regular, and rather deep curves.
Cusp: an acute prominence or tooth.
Concavity: a broad impression or excavation, larger than a fovea; e.g., the declivital concavity in the genus *Ips*, and the frontal concavity in the males of *Trypodendron*.

Declivitous: sloping rather steeply downwards.
Declivity: a steep slope; the usually steep caudal face of the elytra in ipid beetles; also the steep cephalic face of the pronotum in the *Ipinæ* and *Micracinæ*.
Declivous: sloping gradually downwards.
Dehiscent: split or separated along a suture.
Dense: applied to pubescence or punctures very thickly crowded, the margins of the punctures nearly contiguous.
Dentate: toothed.
Denticle: a small tooth.
Depressed: flattened vertically, from above and below.
Disc: the central portion of any outer surface.
Distal: applied to the portion of an appendage or segment farthest from the body.
Distad: the direction away from the body along the middle line of an appendage.
Dorsad: the direction from the venter towards the dorsum, on the meson, at right angles to the longitudinal axis.
Dorsal: pertaining to the dorsum.
Dorsum: the upper surface.

Emarginate: with a notch cut from the margin.
Emargination: a broad or narrow angular or rounded notch breaking the margin.
Epistoma: the cephalic portion of the front of the head between the eyes and the mouth cavity or the base of the labrum when the latter is present.
Epistomal Lobe: a flat depressed lobe directed cephalad from the median portion of the epistomal margin.
Epistomal Margin: in ipid beetles, the dorsal margin of the mouth cavity, that is, the cephalic margin of the epistoma.
Epistomal Process: a flattened dorsal prominence with converging or parallel sides arising from the base of the epistoma with its apex reaching towards or to the epistomal margin.

Face: the outer surface of any part.
Ferruginous: reddish brown.

Form: applied to seasonal, dimorphic, or sexual, constant variations from the normal type of the species.
Fossa –æ: a deep, well-defined groove, as those in which the antennæ lie.
Fovea –æ: a small, well-defined impression.
Front: the dorsal face of the head between the vertex and the epistomal margin.
Frontal: pertaining to the front.
Fumose: smoky.
Fused: grown together at a joint, anchylosed; applied to markings run together.
Funicle: the portion of the antenna between the first segment or scape and the club, composed of between one and seven segments in the ipid beetles, the first of which is called the pedicel.

Geminate: in two similar parts; with the apex emarginate, forming two similar cusps or prominences.
Gena –æ: the sides of the head, the sclerite on each side between the front and the gular suture on the ventral surface.
Generation: all the broods from one series of parent adults, all the progeny of the hibernated young beetles and larvæ will form the first generation; all the progeny of these young adults comprising this first generation will constitute the second generation.
Geniculate: jointed at an angle, knee-like.
Glabrous: smooth, normally without vestiture of any kind.
Granulate: having small elevations or granules on the surface.
Granule: a fine, acute or blunt grain-like prominence on a surface.
Griseus: light gray.
Group: an indefinite section in classification.
Gum-tube: a pitch-tube or resin-tube.

Habitat: the location frequented by an insect or in which it was collected.
Habitus: the aspect or general appearance.
Hair: a slender, thread-like filament.
Hirsute: clothed with long coarse hairs.
Hispid: bristly, with sparse stiff hairs.
Humerus: the basal exterior angle of the elytra, usually with a distinct elevation in ipid beetles.

Insertion: the place or line of attachment of an appendage.
Interspace: the area between two elytral striæ.
Interspatial: pertaining to the interspaces; e.g., punctures, granules and hairs.
Interstria –æ: a secondary stria along the median line of an interspace between two striæ.
Interstrial: interspatial; less commonly, pertaining to the interstriæ.

Joint: an articulation.

Labial: pertaining to the labium.
Labium: the lower lip in insects.
Labrum: the upper lip; absent in the ipid beetles.
Lamella –æ: a thin, more or less plate-like process.
Lamellate: composed of closely placed lamellæ; applied to the antennal club of *Phthorophloeus*, in which the segments of the club are laterally produced, although not truly plate-like.
Lanate: woolly, covered with fine long hairs.
Lunular: crescentic.
Ligula: a somewhat tongue-like labial process arising from the upper face of the mentum.

Maculate: with coloured spots or patches.
Mandible: the 1st pair of jaws in mandibulate insects, used for biting.
Margin: the portion of the segment adjoining the edge.
Marginal: pertaining to the margin, near the edge.
Margined: bounded by a finely elevated marginal line.
Maxilla –æ: the second pair of jaws in mandibulate insects.
Maxillary: attached to the maxilla; maxillary lobe.
Meso–: middle, belonging to the mesothorax, e.g. mesosternum, mesepimeron, mesepisternum.
Mesothorax: the second or middle segment of the thorax.
Mesad: the direction from the side towards and at right angles to the meson.
Meson: the median, longitudinal, vertical plane of the body; the mesial plane.
Meta–: posterior, belonging to the metathorax, e.g., metasternum, metepisternum, metepimeron.
Metathorax: the 3rd segment of the thorax.
Metatype: a specimen named by the author of the species after comparison with the type.
Mucro: a long, pointed process.
Mucronate: bearing an acute process.
Muricate: armed with coarse, acute elevations.

Notum: the dorsal part of a segment, the tergum.

Obtuse: blunt; an angle of more than 90 degrees.
Occipital Foramen: the great opening in the caudal face of the head.
Occiput: the caudal sclerite of the head.
Ogival: curved like the head of a projectile.
Opaque: dull, applied to a surface without lustre.
Ontogeny: the development of an individual organism.

Palmate: with finger-like processes, hand-shaped.
Palp: a feeler, a sensitive, segmented appendage borne by the maxillæ and labium.
Palpus –i: a palp.
Parasite: a species that lives in or upon another organism, called the host, from whose tissues it obtains its nourishment, or from which it derives some other advantage without making adequate return.
Paratype: applied to all specimens studied and definitely chosen by the author in the series from which the type was selected.
Pennate: feather-like in shape.
Phylogeny: the evolution of a group.
Phylogenetic: pertaining to the evolution of groups.
Piceous: pitch coloured, very dark brownish to black.
Pitch-tube: a cylinder of resin surrounding the entrance-hole.
Pilose: clothed with very fine hairs.
Planoconcave: applied to a plane surface very faintly, broadly concave.
Planoconvex: applied to a plane surface very faintly, broadly convex.
Plumose: feathered like a plume.
Plate: any broad, flattened sclerite or area.
Predacious: predatory, living by preying upon other animals; insects which feed upon other insects from the exterior.
Pro –: anterior; applied to the 1st segment of the thorax, as prosternum.
Process: a prolongation of any part of the surface without an articulation.
Procurved: arcuate with the convexity in front.
Produced: drawn out into a rather wide protuberance or prolongation.
Pronotum: the dorsal piece of the prothorax.
Prosternal Process: the median, caudal, intercoxal extension of the prosternum.
Prothorax: the 1st segment of the thorax.
Post –: behind.
Postepistomal: lying immediately behind the epistoma.
Proventriculus: the posterior masticatory portion of the fore intestine, armed with a chitinous internal structure.
Proximad: the direction towards the body along the median line of an appendage.
Proximal: of an appendage, the portion nearer the body.
Pruinose: hoary.
Pseudo –: a prefix meaning false or resembling.
Pubescence: short, soft, fine hair; indefinitely for vestiture.
Pubescent: densely or sparsely covered with fine hair.
Punctate: punctured.
Puncture: a small impression as though made by a sharp or moderately sharp point.
Punctured: applied to a surface marked with punctures.
Punctulate: applied to a surface marked with minute punctures.
Punctate-aciculate: punctured and aciculate.
Punctate-striate: with punctured striæ.

Race: a group of individuals in a species presenting more or less constant and peculiar but minor characters, not of specific importance; often geographic, from another region than the type locality.
Reclinate: reclining, not erect, applied to hairs.
Recurved: arcuate with the convexity behind.
Red-top: a recently killed coniferous tree bearing reddened foliage.
Resin-tube: pitch-tube.
Reticulate: marked with a network of fine impressed or elevated lines.
Retractile: capable of being drawn in or backwards.
Retuse: with the margin or the visible margin when viewed from above broadly rounded and deeply, arcuately emarginate at the middle; e.g., the cephalic margin of the pronotum in some species of *Trypodendron*, and the elytral declivity of species of *Pityophthorus* when deeply sulcate along the suture and the sides of the declivity elevated.
Rostrum: the beak or snout-like prolongation of the front of the head.
Rufous: brick-red.
Rugose: wrinkled, marked with coarse elevations.
Rugosities: moderate or coarse surface wrinkles or strong, usually blunt elevations; equivalent to coarse and blunt asperities.
Rugulose: finely rugose.

Scabrous: rough with numerous small elevations.
Scale: a broad, flattened, scale-like hair.
Scape: the elongate first segment of the geniculate antenna.
Sclerite: a piece of the segment wall, bounded primitively by sutures.
Scrobe: a groove, as that on the side of the beak to receive the antennal scape.
Sculpture: the elevated or impressed markings on the surface.
Scutellum: the subtriangular piece between the bases of the elytra.
Segment: a primary transverse division of an articulate's body, e.g., the prothorax; a section or division of an appendage, bounded primitively by sutures, e.g., the segments of the antennal funicle.
Segmented: divided into evident segments.
Septate: divided by an internal partition or septum.
Sericeous: with a silky lustre from dense, minute pubescence.
Serrate: armed with a row of saw-teeth.
Serrulate: armed with many small saw-teeth.
Seta -æ: a rather short, stiff, pointed hair.
Setigerous: with setæ.
Setose: setigerous.
Setose-punctate: with setæ arising from the punctures.
Sinuate: undulating.
Solid: applied to organs made up of fused segments; applied to an antennal club of apparently only one segment.
Spatulate: shaped like a spatula, applied to an appendage or process, flattened, moderately widened distally and broadly rounded at the apex.
Spine: an elongate, acute process.
Spinose: with spines.
Spiracle: breathing pore, stigma.
Spur: a short, blunt process.
Squamose: scaly.
Sternite: the ventral piece or sclerite of a body segment.
Sternum: the breast piece, the middle ventral sclerite of the thoracic segments.
Stria -æ: a narrowly impressed line, usually longitudinal, especially the parallel impressed, usually punctured, lines on the elytra from base to apex.
Striate: marked with striæ.
Sub -: nearly but not quite the same as the term to which the prefix is applied; e.g., subequal = almost equal, subovate = nearly but not quite oval; also beneath, subcortical = beneath the bark.
Submarginal: an indefinite area well within but not far from the actual edge, within but near the margin.
Subtend: to lie opposite to.
Sulcate: marked with a broad furrow or with parallel grooves.
Sulcate-retuse: applied to the elytral declivity when the median sulcus is broad and deep and the lateral prominences more than usually pronounced; strongly retuse.
Sulcus: a groove or furrow.
Sultural Stria: the first stria on each elytron, usually wider and deeper than the others.
Suture: the longitudinal line along the dorsum marking the junction of the elytra. The name is frequently applied to the two first interspaces, which are commonly conjointly elevated, especially towards the declivity; in this case the suture is said to be elevated or convex.

Tergite: the dorsal part of the segment, especially when it consists of one segment as in the abdomen.
Tergum: the back, the dorsum of the primitive segment.
Tomentose: clothed with densely matted fine hairs.
Tooth: a short acute process, often conical.
Truncate: cut off squarely as though sectioned with a knife.
Tubercle: a small or moderate knob-like prominence, a coarse granule or small blunt tooth.
Tuberculate: marked with tubercles; like a tubercule.
Type: a single specimen selected from a series by the describer to bear his name and label and from which his description of the species is written.
Typical: agreeing with the type of the species in all important characters, without variations.

Uniseriate: in a single row.

Venter: the lower surface of the abdomen; the belly.
Ventral: pertaining to the venter.
Vertex: the top of the insect's head between the occiput and the front.
Vestiture: all the surface clothing, including all hairs, scales, and excrescences.
Villose: clothed with short soft hairs.
Vitta: a longitudinal coloured line or band.
Vittate: striped.

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